RECEIVER CONTROL OF PACING WITH MASS MEDIA: EFFECTS ON COMPREHENSION AND PERSUASION

By

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TABLE OF CONTENTS

page

ACKNOWLEDGMENTS iv

ABSTRACT vii

CHAPTERS

1 INTRODUCTION 1

2 LITERATURE REVIEW 6

- Persuasion in Public Relations 6
- The ELM: An Overview 7
  - Central and Peripheral Routes to Persuasion 7
  - Motivation and Opportunity as Mediators 11
- Media Differences 16
- Explicating “Control of Pacing” 21
- Overview 29
- Nominal Definitions of Variables 31
  - Independent Variable: Control of Pacing 31
  - Dependent Variables: Comprehension and Persuasion 31
- Main Conceptual Hypotheses 32
- Setting up the Study 32

3 METHODOLOGY 34

- Pilot Study 34
  - Procedure 34
  - Pilot Results 36
  - Implications of Pilot and Additional Pretests for Main Study 38
- Methodology for the Main Study 40
  - Participants 40
  - Stimuli 40
  - Procedure 41
  - Operational Definitions: Independent Variables 42
  - Operational Definitions: Dependent Variables 43
  - Operational Hypotheses 50

4 FINDINGS 52

Descriptive Data 52
Hypothesis Tests 55
Post Hoc Analyses 58
    Comprehension 58
    Attitudes toward NASA/Marshall's Science 59
    Attitudes toward Science in General 60
    Interest Index 60
    Informed Index 61
    Individual Items 61

5 DISCUSSION 67

Limitations 67
Participants 69
Implications 70
    Pilot versus Main Study 70
    Main Study Implications 71
Conclusions and Directions for Future Research 76
    For Theorists 76
    For Professionals 78
    For Teachers 79
    General Conclusions 80

APPENDICES

A WEB PAGE STIMULUS (BLACK AND WHITE PRINTOUT) 81

B PILOT QUESTIONNAIRE 85

C NEWSLETTER STIMULUS (BLACK AND WHITE PRINTOUT) 95

D MAIN STUDY QUESTIONNAIRE 97

REFERENCES 107

BIOGRAPHICAL SKETCH 110

Abstract of Dissertation Presented to the Graduate School
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RECEIVER CONTROL OF PACING WITH MASS MEDIA: EFFECTS ON COMPREHENSION AND PERSUASION

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This study tests receiver control of pacing as a variable for examining learning and persuasion outcomes with mass media. Receiver control of pacing is discussed within the framework of the elaboration likelihood model of persuasion in which greater motivation and opportunity to process information are predicted to lead to greater comprehension and persuasion. This model of persuasion where understanding is the foundation for attitude change is consistent with recent prescriptive models of public relations.

A pilot study and pretests were conducted to help formulate the experimental design for the main study. Fifty students from the College of Education participated in the main study's 2X2 factorial design in which receiver control of pacing and the presence of images in the stimuli were the binomial independent variables and comprehension and attitudes toward the stimulus material were the main dependent variables. The four conditions of the main study conveyed a message as it would be presented in the media of radio, print, video and the World Wide Web.

Results of the study showed that print and Web conditions–media that allow receivers control of pacing–had a significant advantage over radio and video in affecting comprehension of the science-related stimulus material from NASA. Control of pacing did not have an advantage in affecting attitudes. Results and limitations of the study are discussed in terms of implications for mass communication theorists, professional communicators and teachers.

CHAPTER 1
INTRODUCTION

Scientists at NASA's George C. Marshall Space Flight Center in Huntsville, Alabama, are studying some of the great mysteries of our universe ranging from the possible existence of microbial organisms in outer space to the sources of the largest, most energetic explosions in the universe. But for the science to continue, scientists must persuade the taxpayers, politicians and corporate decision makers who fund their work–as well as the young people who will someday contribute to the process of scientific inquiry–of the value of their science in the advancement of human knowledge. Therefore, scientists at Marshall also have to figure out how to communicate their knowledge to publics whose interest and ability to appreciate the research are highly variable.

Meanwhile, administrators at the University of Florida in Gainesville are likewise coming to terms with the information age as they wrestle with questions regarding computer requirements for incoming students. In an effort to keep students, faculty and staff competitive in a world of advancing technology, they have to make controversial decisions affecting the cost and character of university education. These administrators must justify to skeptical students increases in the expense of attending college attributable to investments in new technology.

The scientists at NASA and the administrators at Florida have something in common with each other and with people who communicate on behalf of organizations worldwide. Although labels for these functions vary across organizations–from "public affairs" to "university relations" to "corporate communications" to "public relations"–communicators who represent organizations that serve public interests share the task of educating constituents.* Seeing to it that people comprehend communications is an integral aspect of the function of public relations.

Communicators must consider numerous issues in designing and delivering messages to publics, including cost of media space, reach of media and the environment in which publics receive the message. This study cannot address all the possibilities and factors that go into such decisions. Rather the approach taken here begins by establishing a broad theoretical context for mass communication research and focuses on some specific areas where theory may be advanced through the application of its concepts by communicators.

Perhaps the broadest question of mass communication research was forwarded by Harold Lasswell (1964): "Who says what to whom in what channel with what effect?"

This study will apply to communicators who want their publics to learn something before being persuaded. Communicators fall between two hypothetical extremes: the communicator as teacher and the communicator as mass manipulator. An example of the former is the elementary school teacher who, by cultivating literacy, teaches students to value books and learning.

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* Although the connotations of the various job descriptions are subject to debate, this dissertation will refer to the field as "public relations" and the practitioners as communicators."

On the other extreme is the mass manipulator, designing messages with the sole purpose of increasing sales or swaying votes on a referendum, teaching the receiver to agree independent of rational thinking. For the mass manipulator, deception is acceptable if it works to affect behavior. That is, persuasion without thoughtful learning is acceptable to this hypothetical person.

This study addresses the concerns of the former type of communicator who uses mass media to inform large groups of people in ways that shape attitudes by enabling understanding of the legitimacy of a perspective or policy. It focuses on learners who may vary in the degree of their interest in the content, but who are capable of comprehending the messages.

Given a general idea of who says what to whom, a response can be offered to the second part of Lasswell's inquiry, " . . .in what channel with what effect?" This study focuses on receiver *control of pacing* as the main independent variable and *comprehension* and *persuasion* as the main dependent variables, or effects. Specifically, this study examines how different media affect the reception of a message with content designed to enable publics to learn.

Deciding how to present and deliver information based on the interaction of the selected channel with the information itself is one of the most important jobs of professional communicators. In terms of theory, this dissertation evaluates an independent variable by which all media can be assessed, namely, the amount of control the receiver has over the pacing of information. The dependent variable of comprehension and its relationship to attitude formation and change are central concerns of all mass communication scientists. If this study can cast light on the effect of control of pacing on outcomes as critical as comprehension and persuasion, then it can offer a meaningful contribution to the body of knowledge in the field of public relations.

From a practical standpoint, this study aims to provide a better understanding of control of pacing as a factor in designing and delivering information given the increasing array of media options available. In terms of traditional media, such as radio, television and print, control of pacing may affect the way people comprehend and form attitudes from messages. Whereas print allows learners a high degree of control over pacing, broadcast media allow almost no control. What effect does this have on learning and persuasion?

What about new media? Interestingly, newer communication technologies such as the World Wide Web and CD ROMs are more similar to print–the most primitive type of mass medium–than television and radio in terms of receiver control of pacing. But new and future technologies will vary greatly in the amount of control they allow receivers, and this variation will depend in part on the decisions made by communicators.

The questions this study addresses should not be framed as “new media” versus “old media.” While scientists at NASA may be making a decision on how to present an educational message via the World Wide Web or via a video news release (VNR), administrators at the University of Florida may be considering broadcasting a message on a campus radio station and/or presenting it in a print brochure. Identifying which technology was developed most recently will not help these communicators. But identifying relevant characteristics by which media can be compared in terms of their effectiveness in delivering a message will help communicators develop messages and make media decisions.

Another goal of this study is to provide useful information to teachers in the field of mass communication. Through the advancement of theory discussed above, this research will provide teachers useful information to discuss with students regarding how media affect message comprehension and how this media-message interaction affects learning and persuasion outcomes. This research also will help communications teachers explain the importance of thinking of the receiver as an active participant in message reception. Teaching students to write well means teaching them to think of their readers. The idea of considering the receiver of information applies to all communication activities–illustration as well as written and oral communication.

The learning theory discussed and advanced in this study can benefit teachers in all fields. Although the focus is on those working in mass communication, this dissertation will borrow ideas from educational literature with the ambition of returning findings and conclusions useful to both mass communicators and classroom teachers. Indeed, the two fields share the goal of effectively communicating information.

In short, the purpose of this research is to answer the question, "How does receiver control of pacing affect comprehension and persuasion?"

CHAPTER 2
LITERATURE REVIEW

Persuasion in Public Relations

Some public relations scholars prescribe that theorists and practitioners alike steer away from non-rational persuasion. James Grunig, for example, contends that such persuasion is "less desirable" than communication that leads to understanding in the two-way symmetrical model of public relations (1989, p. 38). In the two-way symmetrical model, in which publics and organizations communicate in a balanced manner, publics have the same opportunity to influence organizations as organizations have to influence publics. Grunig stops short of saying attitude change per se necessarily undermines the presuppositions of symmetrical theories of communication. He agrees that mutual understanding and attitude change can be part of the same process.

> It is interesting to note… that recent theories show that attitudes most often change when the approach to communication has been what I would interpret as symmetrical (Petty and Cacioppo, 1981, pp. 255-269)–that is, cognitive effects must precede attitude change. (Grunig, 1989, p. 34)

Then, when Grunig discusses conflict resolution as a presupposition of two-way symmetrical communication, he again stops short of excluding attitude change as part of the process. He cites Petty and Cacioppo's work on persuasion to discuss how the "central route" to persuasion can play a role in symmetrical communication: "using reasoned argument in support of one's position is an important part of conflict resolution in the symmetrical model" (Grunig, 1989, p. 39). He contrasts the central route to the "peripheral route," or "manipulative" form of persuasion, an approach to attitude change which is at odds with his symmetrical presuppositions (p. 39). The central route to persuasion in which attitudes change based on understanding will be the focus of this study.

Petty and his colleagues provide a framework for studying persuasion (c.f., Petty & Priester, 1994; Petty & Cacioppo, 1996). This model, the elaboration likelihood model of persuasion (ELM), has been applied to persuasive communication via both interpersonal and mass channels. The present study will use the ELM together with work from some more education-oriented theorists to characterize how people learn from, and are persuaded by, information provided through various mass media technologies.

The ELM: An Overview

Central and Peripheral Routes to Persuasion

According to the elaboration likelihood model of persuasion, persuasion can happen through two routes. The first route to persuasion is the central route. When the central route is employed, people are persuaded based on thoughtful consideration of cogent arguments. The second route is the peripheral route. Persuasion occurring via the peripheral route is by definition based on shortcuts in logic rather than thoughtful processing of information. The two routes to persuasion exist on opposite ends of a continuum where the likelihood of cognitive elaboration on arguments or statements central to an issue ranges from low (peripheral route) to high (central route).

In a classic demonstration of the ELM, Petty, Cacioppo and Goldman (1981) presented college students with a radio message supporting the idea that students should be required to take a comprehensive exam prior to graduation. This message, as might be expected, is counterattitudinal to most college students. Half the students were told the exam policy would be changed before they graduated. The other half were told that the change would not take place for ten years. The purpose of this manipulation was to vary the amount of personal relevance and motivation to process the message.

Petty, Cacioppo and Goldman also varied the quality of the arguments and the perceived expertise of the source. Half the students heard a message consisting of highly cogent arguments previously tested to ensure they would encourage thinking in support of the issue. For example, "institution of the exams had led to a reversal in the declining scores on standardized achievement tests at other universities" (Petty, Cacioppo & Goldman, 1981, p. 850). The other half heard weak arguments known to produce counterarguing in previous studies (e.g., a friend of the author had to take such an exam and ended up with a great job). Perceived source expertise was manipulated by telling students that the source was either a report from local high school students or a nationally funded study led by a professor of education at Princeton.

After the message was presented, student attitudes regarding the exam policy were measured using self-report, semantic differential (i.e., good-bad, favorable-unfavorable) and Likert-type scales. Students also rated the message source on semantic differentials (i.e., not expert-expert) as a manipulation check.

Petty, Cacioppo and Goldman hypothesized and found a three-way interaction. When the exams were going to start before expected graduation (and the students believed they would be directly affected by the policy), messages were significantly more persuasive in the strong-arguments condition than the weak-arguments condition, and perceived source expertise had no significant effect on attitude change. But when information was less relevant to the students (when the exams were proposed for long after their expected graduation), persuasion was influenced more by source expertise than argument quality. That is, the source with an "expert" label was significantly more persuasive than the "non-expert" source in the low-relevance condition only, where argument quality made little difference.

Petty, Cacioppo and Goldman reasoned that when students were presented with a highly relevant message, the likelihood that they would evaluate the actual merits of the arguments by elaborating on the implications increased. Persuasion occurred via the central route in the high-relevance condition. Whereas, when the students were presented with what they perceived as a less important message, the likelihood of rational elaboration was low, that is, they used shortcuts in reasoning (i.e., expert source = valid argument). Attitudes were formed through the peripheral route in the low-relevance condition.

Petty and Cacioppo (1996) explain the use of "central" and "peripheral" to describe the differences in processing as answering the question, "is the attitude change the result of something central to the issue or peripheral to the issue?" (1997, p. 269). Petty and Priester (1994) define the central route as "involving effortful cognitive activity whereby the person draws upon prior experience and knowledge in order to carefully scrutinize all of the information relevant to determining the central merits of the position advocated" (pp. 98-99). They point out that what one person considers central to a position may be different than what another considers central to the same position. For example, if two people are evaluating a new computer requirement, one may focus on financial aspects only, while the other focuses exclusively on convenience.

Petty and Priester (1994) emphasize that sheer effortful processing does not guarantee valid reasoning. That is, more thinking per se does not necessarily lead to more prudent conclusions, which is only to say that the *quality* of thought matters. The benefits of the central route accrue in situations where attitudes are changed through a thoughtful process of cognitive elaboration of legitimate and warranted arguments.

Therefore, we can hypothesize that strong, rational, sufficiently justified arguments are more likely to persuade than weaker arguments when receivers employ the central route. But weak or insufficiently justified arguments can work–and often do–when receivers use peripheral processing. And given the barrage of mass media messages they receive each day, people cannot be expected to devote central processing to each one. People receiving information take shortcuts in forming attitudes (or confirming attitudes for that matter) based on cues peripheral to the actual merits of a position. When an issue is not very important to receivers, like an exam policy to be implemented long after they graduate, people may reach conclusions based on simple heuristics such as "experts are correct" (Petty & Priester, 1994, p. 101).

Petty and Priester cite several empirical studies demonstrating a number of variables capable of acting as peripheral cues including source likability or attractiveness (Chaiken, 1980; Petty, Cacioppo & Schumann, 1983), number of arguments presented (Alba & Marmorstein, 1987; Petty & Cacioppo, 1984), how long the arguments are (Wood, Kallgren & Priesler, 1985) and the number of other sources said to endorse the same position (Axsom, Yates & Chaiken, 1987).

The peripheral route to persuasion is ethically suspect because it trades on ignorance and duplicity. But attitudes changed via the central route are not only more respectful of audience interests; they are also believed to be more robust than attitudes changed via the peripheral route. "The end result of the effortful information processing involved in the central route is an attitude that is well articulated and integrated into the person's belief structure" (Petty & Priester, 1994, p. 100). Petty and Priester cite reviews of attitude research including Haugtvedt and Petty (1992) and Petty and Krosnick (1995) to show that attitudes changed via the central route to persuasion are more accessible, persistent and predictive of behavior than attitudes that are not so grounded.

But changing attitudes via the central route is not easy and, by definition, is not automatic. Receivers of information must be motivated and able to process the information. Central processing requires more resources than peripheral processing. Motivation and opportunity are the great mediators of persuasion via the central route, and pacing may be related to both.*

Motivation and Opportunity as Mediators

Although the close interdependence of motivation and opportunity makes the concepts difficult to separate as mutually exclusive operational variables, these concepts may serve as useful ways to analyze other independent variables to predict effects on comprehension and persuasion. That someone *can* elaborate on central merits of an argument can be understood by researchers as mainly a question of opportunity, while whether someone has the *will* to elaborate is more a question of motivation.

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* Petty, Cacioppo and others recognize motivation and ability as key mediating variables in ELM. But *opportunity* will be examined as a mediator here instead of *ability*. *Ability* suggests that the internal know-how of receivers varies as a function of the communication environment. But this study examines pacing, a variable in the environment that affects receivers' opportunity to process more than their internal ability.

The most common manipulation of motivation in this body of literature is the variation of personal relevance of an issue. But professional communicators, unlike laboratory experimenters, rarely have the opportunity to manipulate the environment in a manner that makes the content of the message more relevant to receivers. For example, increasing motivation by providing an issue of high personal importance to someone is easy for experimenters who can simply create a situation for the purposes of a study and "debrief" the participants afterward. "Don't worry, you're not really going to have to take that comprehensive exam in order to graduate." But the message itself is not actually changed in these conditions.

This is not to say that the experimental manipulations discussed above have no external validity. Many public relations situations are genuinely important to the receivers of information. "You are going to have to buy a computer if you attend this school. Let us tell you why and make some suggestions for your purchase."

Other situations, however, such as tentative scientific news of a slowly developing environmental problem, may leave communicators with questions of how to increase motivation. In these cases, communicators may exercise some control over which publics they target to receive their message, thereby taking advantage of a pre-existing relationship between certain receivers and the message content. Although the manipulation of personal relevance in the experiments reviewed above sacrifices some external validity, the variation in relevance does reveal insightful information about how people with differing levels of interest in messages will process the messages differently.

But Petty and Priester (1994) note that there are other ways to initiate central processing besides attempting to deliver messages that are immediately relevant to receivers based on manipulated environmental conditions. They cite studies suggesting that using multiple sources, surprising people with unexpected headlines, and summarizing key arguments as questions rather than statements also can induce greater thinking about a message.

For example, Petty, Cacioppo and Heesacker (1981) hypothesized that people would be more persuaded by strong arguments with questions summarizing key points than the same arguments with statements summarizing key points since they would think more about the arguments that asked them questions. And people would be less persuaded by poor arguments with questions rather than statements because, upon further thinking induced by questions, they would recognize the weakness of the arguments.

As predicted, when students in Petty, Cacioppo and Heesacker's study were addressed with a relatively unimportant or low-relevance issue (e.g., an argument addressed to students at one school about instituting a comprehensive exam for seniors at another school), the summary questions appeared to encourage greater consideration of the arguments than summary statements. "When the message was of low personal relevance and recipients were not naturally processing the statement form of the message diligently, the use of rhetoricals enhanced thinking: A message with strong arguments became more persuasive, and a message with weak arguments became less persuasive with rhetoricals" (Petty, Cacioppo & Heesacker, 1981, p. 432).

This introduces some interesting ideas. Apparently, if receivers can be motivated to process central information of little immediate relevance, the resulting comprehension can still persuade them to support the source. For example, if NASA scientists can provide people the opportunity to try to comprehend a story about the basic focus of their research, and people are motivated to centrally process the information, thereby gaining a better understanding of what the scientists are working on, this comprehension may persuade people to support NASA's science enterprises. Does the comprehension-persuasion link hold up in the absence of direct personal relevance? The research above suggests that it may if communicators can create an interest or curiosity that the message serves to satisfy.

This is an important issue because in many cases–especially with complex policy issues and science communication–a considerable amount of comprehension is necessary *before* receivers can see the relevance of the information being presented. Thoughtful processing, comprehension and motivation, then, may become inextricably linked in a productive cycle. Communicators, theorists and teachers must work to support this cycle of motivation and understanding. One of the easiest ways to support this cycle may be to make sure people have the opportunity to comprehend.

In their study of the effects of questions versus statements on elaboration and persuasion, Petty, Cacioppo and Heesacker (1981) also examined high-relevance situations. They found different effects when the topic was of high relevance to the people in their study (e.g., an argument addressed to students about a comprehensive exam they may actually have to take). In the high-relevance condition, questions "appeared to distract subjects from the normal thoughts that they would have been thinking" (1981, p. 438). In other words, when people are not immediately inclined by relevance to elaborate on an argument, questions may draw them into thinking about the message, but when people are already inclined to think about a message anyhow, the questions do not have such an effect. In fact, Petty, Cacioppo and Heesacker argue, the questions may even distract thinking in high-relevance conditions. But they presented their information as a recorded radio message where receivers had no control of pacing. Would the questions have been a distraction if the medium were print?

Burnkrant and Howard (1984) manipulated the placement of questions within a printed text and tested how people reacted to questions placed at the beginning of a text instead of throughout the text. They found that readers were more likely to be persuaded by strong arguments than weak arguments when questions were used at the introduction to a text. But they did not find the distraction effect suggested by Petty, Cacioppo and Heesacker in high-relevance conditions. Rather, Burnkrant and Howard found that the total amount of relevant thinking (measured in terms of number of cognitive responses) did not decrease when the questions were used in the high-relevance condition. They argue that introductory questions "arouse the reader's uncertainty and motivate more intensive processing of message content than statements," and that this processing may hit a ceiling, but it does not decrease in high-relevance situations (Burnkrant and Howard, 1984, p. 1218). Unlike Petty, Cacioppo and Heesacker, who suggested a distraction effect with radio, Burnkrant and Howard presented their text in print format.*

After considering "who says what to whom" then, we progress to another set of questions. Which medium will most effectively deliver a message in terms of both motivation and opportunity to process? That is, what channel to use, and to what effect? Although this decision is often made based on implicit theories, media availability, ease of use and economic resources, the next section of this paper aims to rigorously examine one simple way of comparing media in order to provide an applicable and theoretically useful construct to inform such decisions.

Media Differences

Do media differences affect comprehension and persuasion? Advertising researchers Jacoby, Hoyer and Zimmer (1983) articulated the importance of this question of media differences in terms of broadcast and print media.

> Although many important questions have been raised in conjunction with these media, perhaps none is more basic than the question: which mass medium, if any, is most effective in generating comprehension of the message content being conveyed? This question is far from trivial. It is not only theoretically important... but it also touches upon such vital

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* These differences between the Burnkrant and Howard (1984) findings and those of Petty, Cacioppo and Heesacker (1981) may also be due to the way the questions were written. Burnkrant and Howard (1984) asked introductory questions where the answer was not clearly implicit within the question itself (e.g., "Will passing a comprehensive exam be an aid to those who seek admission to graduate and professional schools?"). This type of question may not affect the same response to the message source as the confirmatory-type questions did in Petty, Cacioppo and Heesacker's high-relevance conditions. For example, in a high-relevance, weak-argument condition, asking, "Don't you agree that . . .?" may be a distraction from the actual argument in that it will lead a message receiver to have negative thoughts about the message source rather than about the message itself.

> spheres of human endeavor as in-school education, on-the-job training, and the judicial process. (p. 202)

In discussing media differences, Jacoby et al. (1983) were influenced by the work of Chaiken and Eagly (1976). Chaiken and Eagly experimented with how individuals were persuaded by messages carried in different media. They hypothesized that comprehension was a prerequisite to persuasion and that the psychology students in their experiment would demonstrate higher levels of comprehension of a legal issue presented in print than the same message presented via videotape or audiotape.

Chaiken and Eagly (1976) also varied the "difficulty" of messages in a legal context. One message was designed to be more difficult than the other. The "easy" message for example included the following statement from a legal dispute.

> Of particular importance is the fact that the company agreed to make the wage increase granted in October of 1972 retroactive to September of 1972. Making the wage increase retroactive cost the company over $9,300. (p. 607)

Whereas the “difficult” version was as follows.

> One particular benefit which should be underscored is that retroactivity to September, 1972 of the wage accretion granted in October of the same year, a benefit which the company financed and the cost of which exceeded $9,300. (p. 607)

Comprehension scores were based on (1) a self-report rating of how difficult the students thought the message was to understand, (2) recall of key arguments, (3) recognition of details of the message on a multiple-choice test and (4) recall assessed by a short-answer test on the details of the message. Chaiken and Eagly found that students demonstrated greater comprehension with the print messages than the audiotaped or videotaped messages in the difficult message condition, where greater opportunity and motivation to process were likely necessary. In the easy message condition, they found little difference based on media. Interestingly, but not surprisingly, Chaiken and Eagly (1976) note that this interaction effect where modality had a greater effect in the difficult-message condition was mostly found in the part of the comprehension measure based on self-reports of difficulty in understanding. Chaiken and Eagly concluded that "the underlying reasons for modality differences in yielding remain unclear" and that future research should address the issue (1976, p. 612).

Chaiken and Eagly's findings suggest an obvious hypothesis. When motivated people are given a message that is difficult enough to produce variance in comprehensibility across receivers, the medium which affords people the greatest opportunity to comprehend the message will indeed be superior in affecting comprehension.

Jacoby et al. (1983) conducted an experiment in which undergraduate psychology students were exposed to either commercial advertising or news programming via either print, radio or television. They measured comprehension as a dependent variable based on a true-false instrument in which half the items were based on "objective restatements of what had actually been said in the communication" and half were based on "inferences which could be drawn from the communication" (Jacoby et al., 1983, p. 206). They found that the print medium conveyed messages more effectively than television or radio modes based on comprehension. They suggested that this media difference might be due to two possible factors. First, they cite Chaiken and Eagly (1976) in stating that the "visual and vocal cues associated with the source in an audio-visual communication may actually 'distract' the receiver from paying attention to message content" (Jacoby et al., 1983, p. 203). Second, they state that "print permits the recipient to digest the material at his or her own pace" as opposed to the "now you see/hear it, now you don't" quality of television and radio (Jacoby et al., 1983, p. 203). Both explanations hint that the receivers had more opportunity and motivation to process messages presented in the print condition than messages in broadcast media. The second explanation is in line with the often-cited works of Jerome Singer and Peter Wright.

Singer (1980) reviewed the differences in the characteristics of television versus print media. He wrote that the "basic problem" with television is that it "is in effect introducing us constantly to new material before we have had a chance to grasp either the printed or verbal and auditory material being presented, and as a result it yields a high rate of information loss" (1980, p. 53). He then discussed how print media remain stable and allow readers to process information at their own pace which leads to more effective retention of information. But Singer (1980), like Chaiken and Eagly (1976) concluded, "by and large the major research comparing the media remains to be done" (1980, p. 58).

Wright (198l) reviewed the media differences literature in the field of advertising and concluded that the evidence available to him was "consistent with the idea that different media can create reception environments that differ markedly in how much opportunity for active thinking is provided" (p. 275).

Kozma (1991) agreed that characteristics of media play a role in influencing comprehension. He reviewed relevant literature on the effects of several media and cited empirical evidence leading to the following conclusion.

> In many situations for fluent readers, reading progresses along the text in a forward direction at a regular rate, and the information could just as well be presented in another, more transient medium. But, on occasion, reading processes interact with prior knowledge and skill in a way that relies

> heavily on the stability of text to aid comprehension and learning. (Kozma, 1991, p. 183)

Kozma also discusses how people process "transient" information like messages sent through broadcast media such as radio and television, but finds less empirical work to discuss the implications of broadcast media on learning. Kozma (1991) joins Singer (1980) and Chaiken and Eagly (1983) in their call for further research in the area. "Surprisingly little research has been done on the effect of pace on comprehension, but this is a potentially crucial variable that may distinguish the process of learning with television and other transient media from learning with stable media, such as text" (Kozma, 1991, p. 193).

Van der Molen and van der Voort (1997) were concerned with whether children (4th and 6th graders) would demonstrate differences in recall of news stories presented on television and in print. They first reviewed empirical studies on media comparisons for recall that were conducted mainly with adults. Among the studies van der Molen and van der Voort (1997) cited, they reported that eight showed superior recall in the print condition and one showed no media differences. Van der Molen and van der Voort (1997) cite Kozma (1991) in explaining "the most frequently offered explanation" for media differences. "Whereas viewers are held to a fixed tempo, readers can digest the news at their own pace, can reread certain passages, and check details, all of which can facilitate the storage of information (e.g., Furnham & Gunter, 1985; Gunter, 1987)" (van der Molen & van der Voort, 1997).

Although audio and visual cues and other aspects may affect learning and persuasion outcomes, the most fruitful area for examining media differences may be one of the simplest. This study will examine media differences based on the simple media characteristic of pacing. Print media allow readers control over pacing and broadcast media such as radio operate at a more-or-less fixed pace. The characteristic of pacing, once explicated, can also be applied to new and emerging communication technologies.

Although mass communication researchers often refer to pacing as a post hoc explanation when reviewing results from studies with different media conditions, the concept of pacing still needs to be examined in a manner that makes it useful in predicting comprehension and persuasion outcomes in mass communication contexts.

According to Stephen Chaffee, the purpose of explication is " . . . as much to strip away surplus meaning from a term as it is to uncover possible meanings" (1991, p. 72). The next section of this literature review aims to accomplish both goals.

Explicating "Control of Pacing"

At face value, pacing is a variable affecting receivers' opportunity to process information, but a closer look will suggest that it may also have motivational components. According to the ELM, people must have both motivation and opportunity to process messages if the central route to persuasion is going to be successful.* While some variables such as the perceived relevance of a message are closely tied to a person's motivation to centrally process information, other variables, such as distractions in the environment and number of times the message is repeated are assumed to affect an individual's opportunity to process. Even if individuals are highly motivated to process a message, then, they may not have the opportunity to process if distractions are present or the message is presented too quickly. In other situations, the individual may have ample opportunity to process information, but will not have the motivation to do so.

One area where researchers have addressed pacing in terms of the ELM is with *speed of pacing* and its effects on opportunity to process. This leads us to an important point of explication. How does *speed of pacing* differ from our focal variable, learner *control of pacing*? Speed of pacing, at its extremes, unquestionably affects opportunity. But many researchers have examined the effects of speed of pacing where its effects on opportunity to process are questionable. Although *speed of pacing* is not the specific focus of this study, a review of the literature addressing the variable will add to our understanding of *control of pacing*.

Speed of pacing has been given many names: time compression, reading time, and rapid speech among others. Studies addressing speed of pacing generally manipulate the amount of information presented in a certain time frame (e.g., the number of words per minute). Marketing and advertising researchers working in this area were initially interested in speed of pacing for at least two reasons.

First, they were interested in finding how much information they could fit into a paid time slot and still expect worthwhile cognitive outcomes from viewers or listeners. Schlinger, Alwitt, McCarthy and Green (1983), for example, reviewed this body of literature and concluded, "The available research suggests that word transmission can be increased mechanically to around 280 words per minute–about a 50% compression or saving of time over the 'normal' rate–with relatively small losses in the comprehension of factual material" (p. 79). Schlinger et al. conducted an exploratory study with commercials for two consumer products and found that a 20% compression had no significant effect on the number of relevant responses to open-ended recall questions when the commercial about a "packaged-goods" product extended a campaign that was "familiar to many consumers" (1983, pp. 80-82). Compression of the other, "unfamiliar" commercial that "was more complex in that the script contained more copy points" made a slightly significant difference in recall ($p < .04$; 1983, p. 82). Nonetheless, Schlinger et al. concluded that their 20% time compression manipulation's effect on cognitive response "was not very great" (1983, p. 83). Perhaps with the less familiar, more complex commercial at higher speeds, listeners had the opportunity, but were less motivated to process the information.

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* Again, Petty and his colleagues use the term *ability* rather than *opportunity*.

This leads to a discussion of a second interest of marketing and advertising researchers–the effect of speed of pacing as a mediator of persuasion. Moore, Hausknecht and Thamodaran (1986) made the connection between the literature on time compression in advertising/marketing research and the ELM. They conducted a series of three experiments with radio commercials compressed to various speeds.

In the first experiment, Moore et al. tested the predictions of the ELM versus alternative hypotheses. They predicted, based on the ELM, that the likelihood of elaboration would decrease as compression increased from 0% to 30% to 60% since opportunity and motivation to centrally process the information would become less likely as speed increased. That is, based on ELM, they expected a negative linear relationship between speed of pace and likelihood of elaboration.

In this experiment, they used a secondary-task technique to measure the amount of elaboration devoted to the message. The secondary-task technique is based on the assumption that more cognitive resources devoted to a primary task will lead to a slower response to a secondary and concurrent task (in this case, touching a response key when a signal tone was played by the experimenter).

Moore et al. tested this prediction in comparison to competing models that predicted that a moderate increase in time compression, 30% compression, would produce optimal cognitive attention by way of increasing source credibility and preference for the way the message is delivered. This prediction was based on previous findings that showed that moderate celerity in delivering information made sources seem more credible and likable. But the results supported the ELM. The quickest response times to the secondary task, indicating the least cognitive attention to the advertising message, occurred in the condition of greatest compression (60%). The non-compressed message (0%) conditions produced the longest response time to the secondary task, indicating the most elaboration on the message itself, and supporting the negative linear relationship between speed of pace and likelihood of elaboration. But realizing the tentativeness of this conclusion, Moore et al. conducted more experiments with different dependent measures.

In a second experiment, Moore et al. examined the cognitive responses to radio commercials for consumer products presented at 0%, 20%, 40% and 60% compression (ranging from 110 to 166 words per minute).* They found that "as exposure rate increased, responses were directed toward execution-related topics, especially the speed of the ad, and away from more 'central' topics such as the product or advertising claims" (1986, p. 92).

Finally, in a third experiment, Moore et al. created two advertising messages for two consumer products (calculators and razors). Along with the time compression variation, they manipulated argument strength and source credibility based on previous work by Petty and his colleagues (see Petty, Cacioppo & Goldman, 1981, discussed above, for an example). Moore et al. then hypothesized, "If compressed ads lower consumers' ability to process message assertions as predicted by the elaboration-likelihood analysis, argument strength should exert less influence and source credibility should exert more influence on brand attitude judgments as presentation rate increases" (1986, p. 93). Once again, the data generally supported the hypothesis. Both central (message quality) and peripheral (source credibility) cues markedly influenced attitudes when the message was presented at 0% and 30% time compression, while at 60% compression, "source credibility appeared to control attitude judgments, and message quality had little impact" (Moore, et al., 1986, p. 93).

Smith and Shaffer (1991, 1995) followed up on this work addressing speed of pacing in terms of the ELM. Smith and Shaffer (1991) tested the effects of rapid speech on persuasion with a more relevant tape-recorded message that was either proattitudinal or counterattitudinal. They presented 101 undergraduates with cogent arguments either opposing or supporting a law requiring people to be 21 years old to buy alcoholic beverages. In line with the ELM, they found that more rapid speech suppressed the likelihood of counterargument (central processing) to the counter-attitudinal message, making the message more persuasive by inhibiting rational thinking. Also in support of ELM, they found that more rapid speech decreased the number of message-favorable elaborations resulting from the pro-attitudinal message. Both findings suggest that central processing was disrupted by speedier presentation leading to less prudent decision making.

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* It is interesting to note that research in this area is inconsistent in defining compression of "normal" pacing in terms of words per minute: 60% time compression equals 166 words per minute for Moore et al. (1986), while 50% time compression equals 280 words per minute for Schlinger et al. (1983). Undoubtedly, "normal" pace is different for different messages.

What does this literature on the *speed of pacing* tell us about how *control of pacing* may affect comprehension and persuasion? The research indicates that speed of pacing affects the opportunity to elaborate, as evident in situations where motivation to elaborate is already as high as a mass communicator could reasonably expect (e.g., addressing 19-year olds on the drinking-age issue or college students on a mandatory senior exam).

But all of these studies on speed of pacing were conducted with media that allow receivers no control of pace for all intents and purposes. The studies yield some useful guidelines for communicators presenting such messages in broadcast media (e.g., 200 words per minute is probably too fast). But it is impossible to designate an optimal processing speed that applies to all individual receivers and all types of message content.

It can be induced that "normal" speeds of pacing encourage greater elaboration on relevant information when compared to more rapid speeds of pacing. But, clearly, what is an optimal speed will vary as a function of message content. At some point a product advertisement or argument for drinking age laws can be so slow that it leads to disengagement rather than active processing. For each individual receiver in each individual situation, then, an optimal pace exists where information is presented slow enough to enable and motivate elaboration and thoughtful, central processing, but not so slow as to bore the receiver. Each individual receiver in each particular situation, then, is best equipped to determine for herself the optimal pace of delivery. Giving the receiver control of pacing is possibly a way of solving the problem of speed of pacing.

Murrie (1998) presented a paper that specifically examined *control of pacing* as an independent variable within the ELM and elaboration as a dependent variable. Murrie suggested that control of pacing, along with choice of content and opportunity to respond, is a key component of interactivity. Although a complete explication of the concept of interactivity is beyond the scope of the current study, Murrie's assertion that control of pacing is a key component would be difficult to oppose. In terms of control of pacing, then, it is interesting to note that "older" media such as print may be more interactive than "newer" technologies such as streaming video.

Students in Murrie's experiment were presented with news stories assumed to be of high personal relevance based on a pilot trial–a story about college costs and a story about the marketing of credit cards on college campuses. Two modes of presentation were used. In one mode the video segment was shown in a linear fashion with a table of contents and then several brief segments. In the other, the same video was offered in the same order, but students had the opportunity to navigate from the table of contents to different segments of the video, pause between segments, or replay segments. Both modes were presented on computer monitors. Murrie employed a crossover design of treatments so that each student was exposed to two different stories and two different formats (e.g., a "linear" version of the college costs story followed by a "non-linear" version of the credit card marketing story).

The independent variable, control of pacing, was measured in terms of the amount of time students paused between segments and the amount of time they spent viewing the material. This variable was fixed in the "linear" conditions, but varied in the "non-linear" conditions since students could pause between segments, repeat segments or skip ahead.

The dependent variable, elaboration, was measured with a think-aloud procedure where students were asked to verbally express the thoughts they had as they viewed. The statements were recorded and coded as elaborations if they were relevant to the content. Murrie found that students elaborated significantly more in the conditions where they had some control over pacing than they did in the "linear" conditions. That is, the mean number of relevant thoughts coded was higher for the conditions when receivers controlled the pace. Many students, when given the ability to control the pace, watched only portions of the story, but still, on average, elaborated more than when pacing was out of their control. This supports the idea that the receiver may best determine an optimal pace for elaboration.

Using regression analysis, Murrie reported that pacing accounted for 29% of the variability in elaboration. Furthermore, elaborations were coded for quality. Rich elaborations were defined as "either multiple sentences or complex/multi-clause sentences that showed thought beyond the facts of the story, especially reactions, qualifications, or examples" (Murrie, 1998, p. 15). The number of rich elaborations was much greater in the "non-linear" conditions. Based on Murrie's criteria then, the number of rich elaborations seems to be an indicator of comprehension.

Murrie hypothesized that control of pacing acts as a mediator of elaboration. In his study, "message modality refers to the pace of presentation, more precisely measured by two other variables, pause time and view time, which will also be considered as independent variables affecting ability to elaborate" (p. 6). This assumption seems in line with the literature reviewed above.

But Murrie's findings also suggest that control of pacing may have had an effect in terms of motivation. Viewers who chose to watch less than the entire video elaborated more than the viewers who could not control the pacing and therefore watched the entire video. It seems reasonable to conclude that control of pacing not only provided people an opportunity to elaborate, but also affected their motivation above and beyond their interest in credit cards and college costs, which affected what and how much information they comprehended. Elaboration was the only dependent variable Murrie measured, but the ELM predicts that greater elaboration will mean greater comprehension and persuasion.

Overview

The elaboration likelihood model holds that persuasion built on a receiver's thoughtful processing of information will lead to robust, articulated attitudes in support of the presented position if the message is well reasoned, legitimate and warranted. In line with recent public relations theory, the central route to attitude formation–with attitudes created, changed or reinforced based on genuine understanding–is desirable for professional communicators.

Mass communication professionals, theorists and educators all face the question of how to best deliver information via mass communication channels to affect such comprehension and persuasion. Of course, the first challenge of communicators is to identify what needs to be said to whom. But the focus of this dissertation is what happens when receivers are exposed to common message content and whether media differences can have an effect on comprehension and persuasion at this point.

Results from studies conducted with different media have shown that comprehension and persuasion outcomes often vary significantly across media, even when the same (or comparable) information is presented as a stimulus. Researchers have speculated that these different findings may be based on the pacing of message delivery.

Pacing–more specifically defined here as control of pacing–seems to offer a logical answer to the questions of media differences raised in the ELM and related mass communication research reviewed. Since receivers of information who can control the pace of delivery will have greater opportunity to process the information at their own optimal pace, they will likely be more motivated to comprehend than those who cannot control the pace of information. And this comprehension should lead to greater persuasion, provided that the message content justifies the attitude change that is sought.

Nominal Definitions of Variables

Independent Variable: Control of Pacing

In this study, control of pacing will be treated as a simple, binomial independent variable. Print and World Wide Web documents allow receivers to control the pacing of delivery. Broadcast television and radio do not.

Dependent Variables: Comprehension and Persuasion

Comprehension

Since the construct of comprehension is useless without reference to the material to be comprehended, measurement of this variable will be based on the receivers' understanding of the specific content presented in the stimulus. Multiple-choice comprehension questions will be developed and pretested to ensure there is enough variability in the measure to make meaningful comparisons across experimental groups. Control of pacing would not be a factor if the message were readily comprehended at a fast pace or on a single pass. Therefore, a message with relatively challenging content will be chosen as the stimulus for this study.

Persuasion

Persuasion outcomes will be based on the favorability of attitudes expressed by receivers after exposure to the stimulus message. As with the comprehension measure, the measure of attitudes used to gauge persuasion will be designed based on the content of the specific stimulus message used.

Main Conceptual Hypotheses

Receivers of information that are allowed to control the pacing of delivery will demonstrate significantly greater comprehension of stimulus material than receivers of comparable information who are not allowed control of pacing. In other words, people who get the information in print or on the Web will perform better on a comprehension measure than people who get the same basic information via television or radio.

If the first main hypothesis is supported, then a second main hypothesis can be forwarded. **Receivers of information that are allowed to control the pacing of delivery will report significantly more favorable attitudes to the content presented in the stimulus than receivers of comparable information who are not allowed control of pacing.** Based on the ELM, those who understand the message better are more likely to support the message's position.

Setting up the Study

To demonstrate these effects, however, receivers of the message will need to have some minimum level of interest in trying to comprehend the information. As discussed above, communicators will do best to target receivers who are somewhat likely to be affected by the message in a way that motivates them to try to comprehend. Another requirement for demonstrating this effect–also discussed above–is to present messages that are likely to produce variable comprehension outcomes. A pilot study will be developed to test the stimulus materials, comprehension measures and persuasion measures.

The scientists at NASA's Marshall Space Flight Center face a communication challenge that this study is particularly well suited to address. People who receive the science information NASA releases must have some minimum level of understanding of the work conducted at Marshall before they can form, change or reinforce their attitudes on space science via the central route. And reports on the work conducted at Marshall seem interesting yet relatively difficult to comprehend for the lay person. In an effort to communicate more effectively, the scientists at Marshall have developed an impressive Web presence while still sending information through more traditional media such as print and video news releases. This study will address whether some media can be more effective than others in delivering specific information that summarizes the work conducted at the space sciences laboratory based on the pacing hypotheses.*

Will the predicted pacing-comprehension-persuasion relationship hold up with this particular information?

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* Again, this research is limited to examining media effects (comprehension and persuasion) once the receiver has actually been exposed to the information sent.

CHAPTER 3
METHODOLOGY

Pilot Study

Procedure

Thirty undergraduate students from the University of Florida's College of Journalism and Communications were recruited to participate in and successfully completed the pilot study. All participants were assigned to one of two media conditions based on the last digit of their identification numbers (15 people in each condition). If the last digit was odd, they were assigned to a classroom where a video was shown. If the last digit was even, participants were assigned to a classroom in the same building where each person was asked to sit at a computer terminal and instructed to view a Web page.

The video stimulus was a four-minute "Year in Review" piece from the space sciences laboratory at NASA's Marshall Space Flight Center. The message highlighted science conducted at the lab in 1997 including brief descriptions of research on global temperature trends, urban heat islands, the sun's effect on the earth's aurora, microgravity science and gamma-ray astronomy. A Web stimulus was created to present the most comparable information possible to the video. The exact same verbal information spoken in the video was presented as text on the Web page, and identical or very similar images were placed along with the text wherever possible to supplement the text in the same manner that the images supplemented the verbal information in the video condition. A printed version of the Web page is included in Appendix A.

Participants in the Web condition were instructed with the following statement once they were seated at the computer terminals. "Now I would like you to go through this Web page at your own pace. We're interested in how effective the page is, so please be careful not to distract others in the room." Participants in the video condition were given similar instructions. "Now I would like you take a look at this video. We're interested in how effective the video is, so please be careful not to distract others in the room." Although participants were told they would be asked to complete a questionnaire, they were not told that the questionnaire would measure comprehension. The instructions were written in an attempt to encourage each participant to be fairly exposed, at minimum, to the material. The hypothesized differences in comprehension are based on differences in motivation and opportunity to process information once individuals are exposed. In the Web condition, two researchers unobtrusively monitored the time of Web use and informally observed the pattern of scrolling.

Participants were asked to complete a questionnaire when they were done with the stimulus material. The pilot questionnaire is included in Appendix B. Participants were not given the opportunity to refer back to the material once they began the questionnaire. An item on the questionnaire in the Web condition asked respondents to describe their reading of the material in terms of skipping sections, skimming, thorough reading or repeat reading. In the video condition, respondents were asked to report their level of attention, or conversely, their level of distraction while viewing the video.

The questionnaire also included multiple-choice questions designed to measure comprehension of the verbal information presented in the stimulus as well as Likert-type items adapted from a National Science Foundation survey on public attitudes toward and understanding of science (National Science Board, 1998). The Likert-type items were designed to measure how interested respondents were in space and science related issues, how informed respondents reported to be on these issues and their level of agreement with various attitude statements.

Some of these items addressed topics not discussed at all in the stimulus (e.g., international and foreign policy issues, agriculture and farming)–responses to these were not expected to differ between groups. Other Likert-type items addressed general science topics not specifically discussed in the stimulus. The rest of the Likert-type items were written to address the specific areas of science discussed in the message stimulus.

Pilot Results

Informal and unobtrusive timing of Web exposure time showed that none of the participants spent more than five minutes viewing the Web page. Two of the 15 finished the Web page and began the questionnaire within two minutes. Most of the others were done with the Web page in three to four minutes, and all were done before five minutes was up. All of the participants in the video group were exposed to the video for 4 minutes, 17 seconds (with closer to three and a half minutes of verbal content if the introductory and closing shots are not counted). Informal observation, then, suggested that participants, for the most part, spent about the same amount or less time exposed to the stimulus as participants in the video condition. Informally watching the participants in the Web condition also revealed that they made use of the scrolling options on the Web page to scroll both down and up. They also clicked on some thumbnail images that were provided as links to larger, more detailed images or animations. But the pattern of scrolling appeared rushed and seemed to indicate skimming and skipping of material more than thorough reading or re-reading.

The self-report data on Web reading (Table 1) corroborated the informal observations to suggest that individuals did exercise some control over the pacing of information.

Table 1. Self-described Pacing in Pilot Web Condition.

Response options	*Number of participants in pilot Web condition selecting the option*
I didn't really read it.	1 (6.7%)
I skimmed through parts of it and skipped other parts.	2 (13.3%)
I read through some of it thoroughly one time, but skipped other parts altogether.	2 (13.3%)
I read through some of it thoroughly one time, and I skimmed the rest.	5 (33.3%)
I read through some of it multiple times and skipped or skimmed other parts.	0 (0%)
I read through all of it one time.	3 (20.0%)
I read through some of it once and I read the rest more than once.	2 (13.3%)
I read through all of it more than once.	0 (0%)
Total	15 (100%)

Of the 15 participants in the video condition who had no control over the pace of presentation, two said they "paid close attention," eight said they "paid moderately close attention," three reported being "moderately distracted" and two reported being "very distracted."

Participants in the Web condition averaged 7.2 correct answers of the 17 possible comprehension items (SD = 2.7). The average comprehension score in the video condition was 8.0 (SD = 2.7). An independent-samples t-test verified this difference was not significant. Additional comparisons of means for individual comprehension items and for grouped comprehension items (i.e., gamma-ray astronomy items, urban heat island items, etc.) also revealed no significant differences.

Implications of Pilot and Additional Pretests for Main Study

The literature review makes a strong argument that control of pacing can affect comprehension and persuasion outcomes in conditions where individuals are somewhat motivated to try to comprehend information. Both groups in the pilot study, however, performed equally poor on the comprehension test, showing no significant comprehension differences between conditions. Without these comprehension differences, differences in attitudes cannot be hypothesized based on the literature. But some alternative explanations related to the methodology emerged that must be considered before the initial pacing-comprehension hypothesis is rejected.

It is possible that the comprehension questions did not provide a valid measurement of the participants' understanding of the material presented in the stimulus. But a review of the textual material in the stimulus and the comprehension questions in the questionnaire makes this explanation seem unlikely, at least in terms of face validity.

It seems more likely that the comprehension items are workable, but that participants were simply not motivated to process the information at a level where control of pacing in the Web condition would be any advantage over the lack of control of pacing in the video condition (e.g., the central route). To explore this explanation, revised instructions were written, and the stimulus and comprehension items were pretested with nine friends of the experimenter on an individual level. Each person was e-mailed the following instructions.

> I have posted a short Web page and I need to have people read it and then answer a few multiple-choice questions so I can gauge their understanding of the material.
>
> At this stage, I'm testing both the message and the test itself to see if my questions get at what the Web page presents.
>
> Anyhow, here's what I'm asking you to do (in the following order). . .
>
> 1) Read the Web page posted at http://grove.ufl.edu/~chargers/NASA.
> 2) When you're done with the Web page, close your Web browser.
> 3) Answer the questions in the next e-mail I send you as best you can without referring back to the Web page, and "reply" the answers back to me.

The comprehension scores from the nine respondents ranged from 11 to 17 correct of 17 possible with a mean of 13. Each of the 17 items was answered correctly by at least half of the respondents. Although this small, purposeful sample is not statistically comparable to the sample who participated in the pilot study, the much-improved test performance suggests that a different procedure for delivering the same stimulus and comprehension questions may be more effective in collecting meaningful data.

Another possible artifact of the methodology may have affected the pilot results in terms of comprehension. It is possible that the visual information presented along with the text distracted viewers rather than supplementing the verbal material. The comprehension questions were written based on the textual information in the stimuli, and the correct answers were either clearly stated in or logically extrapolated from the text. Difficulty in comprehension in both pilot conditions may be partly attributable to the visual information that accompanied the verbal information. Some scholars (e.g., Jacoby et al., 1983; Chaiken & Eagly, 1976) have suggested this distraction effect may be a primary cause of media differences in past research, but the present study is meant to examine the main effect of control of pacing. Therefore, the possibility of images playing a role of distraction rather than providing helpfully redundant or supplementary information must be considered in the design of the main experiment.

Methodology for the Main Study

Participants

The participants for the main study were recruited from the College of Education. These future teachers were chosen for the main study under the assumption that they may be more motivated to view the stimulus with an interest in comprehending the material. Revisions to the actual experimental procedure also were made to increase participants' motivation to process the stimulus. In other words, the participants were recruited and the procedure was changed to encourage more central processing of the stimulus material. Procedural changes will be discussed below.

Stimuli

The Web and video stimuli remained the same as in the pilot study. The print version contained the exact same text as the Web page, but it did not include images and it was formatted as a one-page newsletter. The print version is included in Appendix C. The radio version was produced from a digital audiotape (DAT) of the video soundtrack. To make sure the same verbal information was included in all conditions, a professional radio producer was hired to add his voice to the part of the soundtrack where the video showed silent textual information such as the introduction and subheadings.

Procedure

The main experiment was conducted in a three-office suite on the university campus. But only two conditions were administered at any one time, and no more than one person participated in any condition at a time. Participants were given the opportunity to participate during a wide range of time slots made available during the early weeks of the spring semester of 1999. Each four consecutive time slots were assigned to one of the four conditions using a table of random numbers to determine the order.

After completing the informed consent statement, participants were given the revised instructions in writing as adapted from the pretest. The revised instructions read as follows.

> I appreciate your willingness to come tonight to participate in this study. I'm going to ask you to read a Web page [*or read a newsletter, or view a video, or listen to a radio piece*]. When you're done, I'll ask you to fill out a questionnaire.
>
> I am interested in how different media convey information about science, so some of the questions will measure your comprehension of the material.
>
> When you are completely done with the Web page [*or newsletter, or video or radio piece*], let me know and I'll give you the questionnaire.
>
> When you do get to the questionnaire part, please be genuine in your responses to the questions–this research is very important to me.

Thanks again!

Participants then read, viewed or listened to the stimulus. Participants in the Web and print conditions were unobtrusively timed from the time they were presented with the stimulus to the time they asked for the questionnaire. When participants completed the questionnaire, the experimenter debriefed the participants.

Operational Definitions: Independent Variables

Control of pacing

This variable was treated as a binomial variable, but four conditions rather than two were set up in the main study: video, radio, Web and printed text (no images). Participants in the video and radio conditions did not control the pacing of delivery of information. Participants in the Web and printed text conditions were allowed to read the material at their own chosen pace.

For more detailed analysis of the control of pacing exercised by participants, exposure time was recorded in the Web and print conditions. Furthermore, participants in these conditions were asked to answer the following question as the first item on their questionnaire.

Which of the following best describes your reading of the material?

1. I didn't really read it.
2. I skimmed through parts of it and skipped other parts.
3. I read through some of it thoroughly one time, but skipped other parts altogether.
4. I read through some of it thoroughly one time, and I skimmed the rest.
5. I read through some of it multiple times and skipped or skimmed other parts.
6. I read through all of it one time.

7. I read through some of it once and I read the rest more than once.
8. I read through all of it more than once.
9. Other: ____

Images

Like control of pacing, the presence of images in the stimulus was treated as a binomial variable. Participants in the video and Web conditions were exposed to stimuli with supplementary visual images (Appendix A). Participants in the radio and printed text conditions were exposed to only the verbal information in oral or printed form.

The two, binomial, independent variables can be analyzed in a 2X2 experimental design (Table 2).

Table 2. Four Conditions of the 2X2 Experimental Design.

	No control of pacing	*Control of pacing*
No images	Radio	Print
Images	Video	Web

Operational Definitions: Dependent Variables

Comprehension

Comprehension was measured in the main study with the same 17-item test administered in the pilot and pretest–the last 17 items on the questionnaires in Appendix B and Appendix D. An index for all 17 questions was used to measure comprehension of the stimulus material where one point was assigned for each correct answer.

Persuasion

Persuasion was measured with Likert-type questions adapted from the National Science Foundation (NSF) survey on public attitudes and understanding of science and technology (National Science Board, 1998), and additional Likert-type questions were written specifically to address issues discussed in the stimulus. Several attitude items were created from these questions including measures of how much people agreed that certain science activities *are necessary*, how much people agreed that certain science activities should be *supported by the federal government*, and how much people agreed with attitude statements on scientific inquiry and technology in general.

Items used in the pilot study that did not pertain to science and technology in general or the specific areas of science and technology discussed in the stimulus were removed from the questionnaire and not used in the main study.

Combined index of attitudes toward science and technology in general.

The Likert-type items in Table 3, Table 4 and Table 5 also were adapted from the NSF telephone surveys (National Science Board, 1998) to the self-administered questionnaire format of the current study and combined to measure attitudes about science and technology in general. Respondents were asked to indicate their level of agreement with each item on a five-point response scale ranging from strongly disagree to strongly agree.

Table 4 and Table 5 present items adapted from two indices in the NSF studies for use in the present study. These indices were labeled "index of scientific promise" and "index of scientific reservations" in the NSF studies. A five-point response scale ranging from strongly disagree to strongly agree was used in both, but the items in Table 5 were reverse coded in gauging attitudes toward science.

Table 3. Likert-type Items on Scientific Research in General.

Even if it brings no immediate benefits, scientific research which advances the frontiers of knowledge is necessary.
Even if it brings no immediate benefits, scientific research which advances the frontiers of knowledge should be supported by the federal government.

Table 4. Items from NSF's Index of Scientific Promise.

Science and technology are making our lives healthier, easier and more comfortable.
Most scientists want to work on things that will make life better for the average person.
With the application of science and new technology, work will become more interesting.
Because of science and technology, there will be more opportunities for the next generation.

Table 5. Items from NSF's Index of Scientific Reservations.

We depend too much on science and not enough on faith.
It is not important for me to know about science in my daily life.
Science makes our way of life change too fast.

Index of attitudes toward the science reported in the stimulus. To measure attitudes regarding the specific areas of science discussed in the stimulus–science conducted at NASA's Marshall Space Flight Center in 1996–an index of the 11 items in Table 6 was created. The first ten items are based on the five specific areas of science discussed in the stimulus. The last item in Table 6 was originally written for the NSF studies and was included because it is directly relevant to the material presented in the stimulus. Again, a five-point response scale ranging from strongly disagree to strongly agree was employed.

Table 6. Attitude Items for Specific Areas of Science.

Scientific research on global temperature trends is necessary.

Scientific research on global temperature trends should be supported by the federal government.

Scientific research on urban heat islands is necessary.

Scientific research on urban heat islands should be supported by the federal government.

Microgravity science is necessary.

Microgravity science should be supported by the federal government.

Scientific research on how solar events affect earth is necessary.

Scientific research on how solar events affect earth should be supported by the federal government.

Scientific research on gamma ray bursts is necessary.

Scientific research on gamma ray bursts should be supported by the federal government.

A final item on the questionnaire, "it is important for me to know about science in my daily life," was included as a check on the validity of responses to the attitude items (see third page of Appendix D). Data from respondents who offered the same answer to this item as they offered to the question, "it is not important for me to know about science in my daily life" (e.g., those who agreed with both items), were removed from the overall data set. Otherwise, this final item was included in the index of attitudes toward science in general.

Two attitude indices, then, were created to measure two variables. The first one includes all of the items from Table 3, Table 4 and Table 5 as well as the data-check item mentioned above. This ten-item index will be referred to in the remainder of this study as the index of attitudes toward science in general.

The second attitude index is comprised of the 11 items in Table 6. This index will be referred to in the remainder of the study as the index of attitudes toward NASA/Marshall's science.

Selecting an appropriate midpoint for Likert-type items. The NSF telephone survey included many Likert-type items for which "don't know" was not explicitly included as a response option to attitude items but accepted if offered spontaneously by respondents. As Schuman and Presser noted, the decision of whether or not to explicitly include a midpoint is often based on the assumptions of the researcher: "...when survey investigators decide against offering an explicit middle alternative, they are usually assuming that the middle category consists largely of responses from those who lean toward one or the other polar alternatives, although perhaps with little intensity" (Schuman & Presser, 1981, pp. 161-162). In this study, where the hypotheses are based on the idea that attitudes are formed, changed or reinforced based on learning and comprehension, it was not assumed that respondents necessarily have crystallized attitudes toward one polar alternative.

Therefore, "don't know" was offered in the pilot study as an explicit midpoint, and a large percentage of respondents chose it for many attitude items. But upon further thinking about the middle response option, "neutral" seemed to make for a more logical semantic midpoint than "don't know" or "undecided" on a unidimensional response scale that ranges from "strongly disagree" to "strongly agree." "Don't know" or "undecided" may encourage respondents to breeze through questions by offering less thoughtful responses to the attitude items. Both "neutral" and "undecided," however, are commonly used as midpoints on Likert-type response scales.

Armstrong specifically addressed the question of whether the use of "undecided" as a middle response option on a five-point Likert-type scale yields significantly different results than the use of "neutral" with "undecided" also offered as "a no-answer alternative" (1987, p. 359). Armstrong made 55 comparisons (11 items with five different groups of participants) of attitude items regarding a local school board. He found only two conditions where the attitude measurements differed significantly between the five-point response scale with "undecided" as the midpoint and the measures with "neutral" as a midpoint and "undecided" as an additional response option. Armstrong concluded that the differences were "negligible."

> It appears no particular erosion takes place when "undecided" is utilized instead of "neutral" and "undecided;" however, from a semantic viewpoint "neutral" seems less ambiguous and should probably be employed when whenever a midpoint is being employed, at all. (1987, p. 362)

Based on results from the pilot study, assumptions about this particular topic and available research evidence, attitude items in the main study included a midpoint to allow respondents who had not crystallized their attitudes an appropriate response option. Specifically, the five-point response scale for the items in Tables 3 through 6 included "neutral" as a midpoint since it represents a semantically consistent middle option between "agree" and "disagree." Although some respondents who were truly undecided or didn't know where they stood on these issues may not have fit perfectly into this category, it was assumed that this would not lead to any significant systematic error in the analyses. In addition, the use of "neutral" rather than "don't know" may have encouraged a more thoughtful response to each item.

Indices for additional analyses

Two more sets of items were included in the questionnaire for additional analyses and exploratory purposes. The first set included items written to measure how interested participants were in various areas of science and technology including areas specifically discussed in the stimulus. Participants were asked to indicate their level of interest on a response scale ranging from 1 = not at all interested to 5 = very interested on the following 10 items: new scientific discoveries, the use of new inventions and technologies, space exploration, environmental pollution, military and defense policy, global temperature trends, urban heat islands, microgravity science, how solar events affect earth, and gamma ray bursts. This index will be referred to as the interest index in the remainder of this study.

The second set of additional items asked participants to report how informed they were on the same issues: new scientific discoveries, the use of new inventions and technologies, space exploration, environmental pollution, military and defense policy, global temperature trends, urban heat islands, microgravity science, how solar events affect earth, and gamma ray bursts. For these items, participants were asked to use a response scale that ranged from 1 = not at all informed to 5 = very informed. This index will be referred to as the informed index in the remainder of this study.

Operational Hypotheses

The first hypothesis predicts a main effect for control of pacing on total comprehension scores. **H_1: The main effect for control of pacing in the 2X2 analysis of variance will be significant at $p < .05$, with the mean comprehension score greater in conditions where participants have control of pacing.**

A second hypothesis serves to challenge the idea that the visual cues in these particular stimuli will interfere with comprehension. Supplementary information that enhances comprehension by tying verbal information to illustrations is predicted to aid comprehension. Therefore, this hypothesis predicts a main effect for the presence of images on total comprehension scores. **H_2: The main effect for the presence of images in the 2X2 analysis of variance will be significant at $p < .05$, with the mean comprehension score greater in conditions where the stimulus includes images along with verbal information.**

Table 7. Predicted Direction of Mean Comprehension Scores in 2X2 Analysis.

	No control of pacing	*Control of pacing*
No images	Radio (least comprehension)	Print
Images	Video	Web (greatest comprehension)

The next set of hypotheses logically follows the first set based on the prediction that greater comprehension will lead to greater persuasion. Higher scores on the index of attitudes toward NASA/Marshall's science will indicate greater persuasion.

The third hypothesis predicts a main effect for control of pacing on attitudes toward the science highlighted in the stimulus material. **H_3: The main effect for control of pacing in a 2X2 analysis of variance will be significant at $p < .05$, with the mean index score of attitudes toward NASA/Marshall's science greater in conditions where participants have control of pacing.**

The fourth hypothesis, like the second, serves to challenge the idea that the images in these particular stimuli will interfere with comprehension and hence persuasion. It predicts a main effect on attitudes for the presence of images. **H_4: The main effect for the presence of images in a 2X2 analysis of variance will be significant at $p < .05$, with the mean index score of attitudes toward NASA/Marshall's science greater in conditions where the stimulus includes images along with verbal information.**

Table 8. Predicted Direction of Mean Attitudes toward NASA/Marshall's Science.

	No control of pacing	*Control of pacing*
No images	Radio (least favorable attitudes)	Print
Images	Video	Web (most favorable attitudes)

The fifth hypothesis predicts a positive linear relationship between comprehension and persuasion regardless of condition. **H_5: Comprehension scores will correlate positively at $p < .05$ with the mean index scores of attitudes toward NASA/Marshall's science across all four conditions.**

CHAPTER 4
FINDINGS

Descriptive Data

Fifty undergraduate students from the College of Education participated in the main experiment. Two participants marked agreement with both "it is important for me to know about science in my daily life" and "it is not important for me to know about science in my daily life." Data from these two participants were removed from the overall data set as discussed in the previous chapter. Of the remaining 48 students, 11 participated in the print condition, 12 participated in the video condition, 12 participated in the radio condition and 13 participated in the Web condition.

Of the 24 who participated in conditions where they had no control of pacing (radio and video), 5 reported paying very close attention, 15 reported paying moderately close attention, 3 said they were moderately distracted and 1 chose "other" as a response option to the first item on the questionnaire.

The self-described pacing for the 24 participants in the print and Web conditions is presented in Table 9.

Table 9. Self-described Pacing in Control-of-pacing Conditions.

Response options	*Participants in control-of-pacing conditions selecting the option*
I didn't really read it.	0 (0%)
I skimmed through parts of it and skipped other parts.	0 (0%)
I read through some of it thoroughly one time, but skipped other parts altogether.	0 (0%)
I read through some of it thoroughly one time, and I skimmed the rest.	1 (4.2%)
I read through some of it multiple times and skipped or skimmed other parts.	1 (4.2%)
I read through all of it one time.	2 (8.3%)
I read through some of it once and I read the rest more than once.	16 (66.7%)
I read through all of it more than once.	4 (16.7%)
Total	24 (100%)

Participants in the control-of-pacing conditions also were timed unobtrusively by measuring the amount of time that elapsed from when they were presented the stimulus to when they asked for the questionnaire. Exposure to the stimulus in these conditions ranged from 158 seconds to 420 seconds with a mean of 283.00 seconds (SD = 85.77). In the video condition, participants were exposed to the video for 257 seconds, but the verbal material in the video (i.e., not counting the dissolve shots, etc. at the beginning and end) lasted 211 seconds. The edited radio version of the verbal content, where pauses in the sound were shortened to maintain a more natural sounding continuity, lasted 198 seconds. On average, then, participants in the control-of-pacing conditions spent 72 to 85 seconds longer exposed to the verbal stimulus material than those who did not control the pacing of information.

On the 17-point comprehension measure, scores ranged from 3 to 17 with a mean of 11.00 (SD = 3.14). Figure 1 displays the distribution of comprehension scores among the 48 participants.

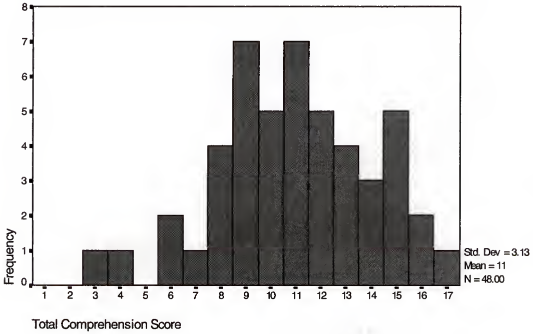


Figure 1, Histogram of Total Comprehension Scores

For the index of attitudes toward science in general, scores were created by averaging each individual's response for the 10 items combined from Tables 3, 4 and 5. The index scores ranged from 2.60 to 4.80 with a mean of 3.78 (SD = .42). The standardized item alpha for these 10 items as a scale is .71. No single item can be removed from the scale to improve the alpha score by more than .01.

The index of attitudes toward NASA/Marshall's science was created by averaging each participant's responses to the 11 items in Table 6. The index scores ranged from 2.45 to 5.00 with a mean of 3.39 (SD = .44). The standardized item alpha for these 11 items as a scale is .87. No single item can be removed from the scale to improve the alpha score by more than .01.

The responses to the 10 items written to measure how interested participants were in various areas of science and technology, including areas specifically discussed in the stimulus, were also used to create an index. The index of interest scores ranged from 1.80 to 5.00 with a mean of 2.76 (SD = .64). The standardized item alpha for these 10 items as a scale is .87. No single item can be removed from the scale to improve the alpha score by more than .01.

The final index was created by averaging each participant's responses to 10 items that asked them to report how informed they were on the same issues included in the interest index. The index of scores ranged from 1.30 to 4.00 with a mean of 2.20 (SD = .55). The standardized item alpha for these 10 items as a scale is .88. No single item can be removed from the scale to improve the alpha score.

Hypothesis Tests

Hypothesis 1, "the main effect for control of pacing in the 2X2 analysis of variance will be significant at $p < .05$, with the mean comprehension score greater in conditions where participants have control of pacing," was supported.

Hypothesis 2, "the main effect for the presence of images in the 2X2 analysis of variance will be significant at $p < .05$, with the mean comprehension score greater in conditions where stimulus includes images along with verbal information," was not supported.

Table 10 and Figure 2 display the mean comprehension scores for each group. Table 11 displays the results of the 2X2 analysis of variance.

Table 10. Mean Comprehension Scores.

	No control of pacing	*Control of pacing*
No images	Radio 9.33 (SD = 2.77)	Print 11.09 (SD = 2.53)
Images	Video 10.58 (SD = 3.50)	Web 12.69 (SD = 2.53)

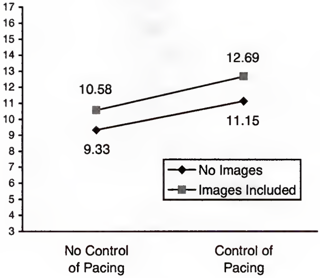


Figure 2, Mean Comprehension Scores

Table 11. ANOVA for Comprehension Scores.

Source	*df*	*MS*	*F*
Control of pacing	1	44.69	5.05*
Images	1	24.31	2.75
Interaction	1	.37	.04

*p < .05

Hypothesis 3, "the main effect for control of pacing in a 2X2 analysis of variance will be significant at $p < .05$, with the mean index score of attitudes toward NASA/Marshall's science greater in conditions where participants have control of pacing," was not supported.

Hypothesis 4, "the main effect for the presence of images in a 2X2 analysis of variance will be significant at $p < .05$, with the mean index score of attitudes toward NASA/Marshall's science greater in the conditions where the stimulus includes images along with verbal information," was not supported.

Table 12 displays the mean index scores of attitudes toward NASA/Marshall's science for each group.

Table 12. Mean Index Scores of Attitudes toward NASA/Marshall's Science.

	No control of pacing	*Control of pacing*
No images	Radio 3.39 (SD = .30)	Print 3.29 (SD = .37)
Images	Video 3.67 (SD = .62)	Web 3.21 (SD = .26)

Table 13 displays the results of the 2X2 analysis of variance.

Table 13. ANOVA for Mean Index Scores of Attitudes toward NASA/Marshall's Science.

Source	*Df*	*MS*	*F*
Control of pacing	1	.94	5.58*
Images	1	.11	.66
Interaction	1	.37	2.19

*p < .05
Note: this effect is not in the predicted direction.

Hypothesis 5, "the mean comprehension scores for all conditions combined will correlate positively at $p < .05$ with the mean index scores of attitudes toward NASA/Marshall's science," was not supported. The Pearson correlation for these two indices across all four conditions was .12 and was not significant.

Post Hoc Analyses

Comprehension

Since the main effect for control of pacing on the 17-point comprehension test was significant, a least-significant-difference (LSD) test was conducted as a post hoc comparison among the four conditions. At the .05 level, only one pair of conditions differed in terms of comprehension. Respondents in the Web condition (M = 12.69, SD = 2.53) scored significantly higher on the comprehension test than participants in the radio condition (M = 9.33, SD = 3.03).

In addition to testing the Pearson correlation between comprehension scores and attitudes toward NASA/Marshall's science for H_5, correlations were calculated for the timing measure and all of the index variables. Of these variables, comprehension only correlated significantly with the time of exposure ($r = .55$, $p < .01$). The correlations for time of exposure were only conducted with the cases in control-of-pacing conditions (print and Web) since control of pacing was fixed in the video and radio conditions. Table 14 displays the Pearson correlations.

Table 14. Pearson Correlations among Time, Comprehension and Index Items.

	Comprehension	*Attitudes toward NASA science*	*Attitudes toward science in general*	*Interest index*	*Informed index*
Time	.55** (23)	.46* (23)	.25 (23)	.30 (22)	.10 (23)
Comprehension		.12 (48)	.07 (47)	.16 (47)	.02 (48)
Attitudes toward NASA/ Marshall's science			.54*** (47)	.57*** (47)	.47** (48)
Attitudes toward science, general				.31* (46)	.43** (47)
Interest index					.68*** (47)

Numbers in parentheses represent the number of cases.
*$p < .05$, ** $p < .01$, ***$p < .001$

Attitudes toward NASA/Marshall's Science

Although H_3 and H_4 were not supported, the main effect for control of pacing on attitudes toward NASA/Marshall's science was significant in the opposite direction than predicted. That is, the control-of-pacing groups reported less favorable attitudes than the no-control-of-pacing groups. A least-significant-difference (LSD) test was conducted as a post hoc comparison between the four conditions at the .05 level. The video group had significantly more favorable attitudes (M = 3.67, SD = .62) toward NASA/Marshall's science than the Web condition (M = 3.21, SD = .26) and the print condition (M = 3.29, SD = .37).

Attitudes toward NASA/Marshall's science correlated significantly with attitudes toward science and technology in general ($r = .54$, $p < .001$), the interest index ($r = .57$, $p < .001$) and the informed index ($r = .47$, $p < .01$).

Attitudes toward Science in General

Although no hypotheses were stated about attitudes toward science in general, a 2X2 ANOVA (control of pacing by presence of images) was run for exploratory purposes. No significant effects were found.

As reported above, attitudes toward science in general correlated significantly with attitudes toward NASA/Marshall's science. Attitudes toward science in general also correlated significantly with the interest index ($r = .31$, $p < .05$) and the informed index ($r = .43$, $p < .01$).

Interest Index

The interest index was comprised of ten items written to measure how interested participants were in various areas of science and technology including areas specifically discussed in the stimulus. Again, a 2X2 ANOVA was calculated for exploratory purposes. Only a marginal main effect ($F = 3.74$, $p = .06$) was found for control of pacing. Interest index scores in the control-of-pacing conditions were less than interest index scores in the no-control-of pacing conditions.

In addition to correlating significantly with attitudes toward NASA/Marshall's science and attitudes toward science in general, the interest index correlated significantly with the informed index ($r = .68$, $p < .001$).

Informed Index

Another 2X2 ANOVA based on the two, binomial, independent variables was calculated for the informed index. The informed index was created from a set of additional items that asked participants to report how informed they were on the same ten issues used in the interest index. No significant effects were found.

As reported above, the informed index correlated significantly with attitudes toward NASA/Marshall's science, attitudes toward science in general and the interest index.

Individual Items

Several individual items were also included in the questionnaire. The first such item asked participants, "All things considered, would you say the world is better off or worse off because of science?" Forty-seven of the 48 participants (97.9%) answered that they thought the world was better off because of science.

Responses to the five additional individual items are summarized in Tables 15-19.

Table 15. “Which area of science would you like to learn more about?”

Response options	*Participants selecting the option*
Global temperature trends	17 (35.4%)
Urban heat islands.	5 (10.4%)
Microgravity science	4 (8.3%)
Solar events	16 (33.3%)
Gamma ray bursts	2 (4.2%)
Other (or more than one option selected)	4 (8.3%)
Total	48 (100%)

Chi-square tests were conducted to determine if responses to this item (Table 15) differed based on control of pacing, presence of images or individual medium. No significant differences were found.

The following four items (in Tables 16-19) were adapted from items that already included logical midpoints in the NSF studies, such as “results about equal” as a midpoint for the item in Table 16 (National Science Board, 1998). In the present study, "don't know” was added to each of these items for the purpose of additional analyses between conditions.

Table 16. “People have frequently noted that scientific research has produced both beneficial and harmful consequences. Would you say that, on balance, the benefits of scientific research have outweighed the harmful results, or have the harmful results of scientific research been greater than its benefits? Please select one answer.”

Response options	*Participants selecting the option*
Beneficial results much greater	25 (52.1%)
Beneficial results slightly greater	16 (33.3%)
Results about equal	2 (4.2%)
Harmful results slightly greater	2 (4.2%)
Harmful results much greater	0 (0%)
Don’t know	3 (6.3%)
Total	48 (100%)

Two types of analyses were run on this item (Table 16). First, responses were recoded into a binomial variable based on whether respondents offered a specific opinion or answered “don’t know.” Three chi-square tests were calculated to see if this recoded binomial variable differed based on control of pacing, presence of images or specific medium. No significant differences were found. Second, a 2X2 ANOVA was calculated with the ordinal data from those who offered an opinion (e.g., the 45 participants who did not answer with “don’t know”) as the dependent variable. No significant effects were found.

The item in Table 17 was analyzed in the same manner as the item in Table 16. No significant effects were found.

Table 17. "Many current issues in science and technology may be viewed as a judgment of relative costs and benefits. Thinking about the space program, some persons have argued that the cost of the space program may have exceeded its benefits, while other people have argued that the benefits of space exploration have exceeded its costs. In your opinion, have the costs of space exploration exceeded its benefits, or have the benefits of space exploration exceeded its costs?"

Response options	*Participants selecting the option*
Benefits substantially greater	25 (52.1%)
Benefits slightly greater	16 (33.3%)
Benefits about equal to costs	2 (4.2%)
Costs slightly greater	2 (4.2%)
Costs substantially greater	0 (0%)
Don't know	3 (6.3%)
Total	48 (100%)

When responses to the item in Table 18, "Is the government spending too little money, about the right amount, or too much money on exploring space?" were recoded into a binomial variable (know/don't know), the chi-square tests showed no significant differences.

Table 18. "Is the government spending too little money, about the right amount, or too much money on exploring space?"

Response options	*Participants selecting the option*
Too little	4 (8.3%)
About the right amount	14 (29.2%)
Too much	11 (22.9%)
Don't know	19 (39.6%)
Total	48 (100%)

A 2X2 ANOVA of the 29 responses where participants expressed an opinion was also calculated. This variable was coded as follows: 1 = "too little," 2 = "about the right amount" and 3 = "too much." The ANOVA showed a significant main effect for control of pacing where, on average, those with no control of pacing expressed the opinion that government spending on space exploration was close to "about the right amount" (M = 1.93, SD = .62) and those with control of pacing leaned more toward the opinion that government spending on space exploration was "too much" (M = 2.53, SD = .64). An LSD test at the .05 level showed that respondents in the print condition (M = 2.80, SD = .45) were significantly less 'generous' in their responses than those in the video (M = 1.88, SD = .64) and radio (M = 2.00, SD = .63) conditions.

The effect for presence of images in the stimulus was not significant.

The same types of analyses were conducted with the item in Table 19 as with the three preceding items. The analyses yielded no significant findings.

Table 19. “Is the government spending too little money, about the right amount, or too much on supporting scientific research?”

Response options	*Participants selecting the option*
Too little	10 (20.8%)
About the right amount	14 (29.2%)
Too much	2 (4.2%)
Don’t know	22 (45.8%)
Total	48 (100%)

CHAPTER 5
DISCUSSION

Limitations

This study examines only a small part of the process of mass communication with a limited group of people and a specific and limited stimulus message. Although the results offer interesting and useful information for mass communication theorists, practitioners and teachers, any generalization of the findings gained from this study must be considered with caution.

The students who participated in both the pilot and the main study are not representative of a very large population. This point is illustrated by the different results between the pilot study and the main experiment. Along with changes in methodology, it appears that recruiting students from two different colleges–even on the same university campus–led to different findings.

Both the experimental instructions and participant pool were adjusted after the pilot study to encourage more motivated processing of the information presented in the stimulus. This boost in motivation, evident in the change in comprehension scores, largely resulted from methods more readily available to an experimental researcher than professional communicators. The main experiment picks up at a point in the communication process that many messages never reach. That is, this study begins examining mass communication processes assuming that receivers of information have chosen our message from the myriad mass media messages available, sat down to give the message relatively direct attention and mustered the motivation to learn from the material. This is not to say that this type of communication process rarely occurs. Rather, as professional communicators are well aware, getting messages to the point where this study starts is a main challenge of their work.

Another major challenge lies in developing messages that have the effect we intend them to have once people process them. The message from NASA was limited in this sense. In hindsight, and in light of the predicted persuasive effect of the message, it is not difficult to understand why the message may not have changed attitudes via comprehension. The message, which included less than four minutes of verbal content as presented in typical broadcast media, was limited in the quantity and quality of information it could provide. Although this amount of time also can be framed as a generous time slot in the world of broadcast news, it reveals one of the major limitations of public relations. Namely, conveniently reaching a broad audience often means sacrificing the quality of a message.

Another limitation is that messages presented via different media in this study were comparable, but not exactly the same. The experiment was designed so that the use of supplementary images could be accounted for. But other cues such as facial expressions and voice intonations could not be reproduced equally across conditions. Nonetheless, the difficulty in designing messages for different media with different characteristics–especially control of pacing–is an issue all mass communication professionals must consider. This study provides data that help us understand the advantages and disadvantages of different media in delivering information effectively.

This section of the discussion highlights the main limitations of this study. Other, more subtle limitations will be discussed in the context of the implications drawn from the data.

Participants

The implications of the main experiment also can be better discussed with an understanding of the undergraduate students in the University of Florida's College of Education who participated in it and their attitudes toward science. Across all four conditions, 47 of the 48 indicated that they believed the world was better off because of science. This finding suggests that the NASA material was not being presented to an audience of adversaries. Their attitudes toward science and technology in general, and toward the science conducted at NASA's Marshall Space Flight Center specifically, can be described as neutral to mildly favorable (mean index scores of 3.78 and 3.39, respectively, based on a 5-point response scale). But the students in this study reported being less interested and informed about the topics (index scores of 2.76 and 2.20, respectively, based on a 5-point response scale) than they were supportive.

Although attitudes expressed in the questionnaire may reflect changes that occurred as a result of the experimental conditions, an overview of the data and informal conversations during debriefing suggest that attitudes did not swing appreciably from one direction to the other because of the stimulus. That is, students did not come to the experiment with strong negative opinions about NASA and related science that were altered as a result of the experiment. Instead, they likely held mildly favorable attitudes toward NASA all along.

Given this broad-stroke description of the participants' dispositions, this group made for an acceptable target public in the sense that they did not harbor extreme attitudes in either direction regarding the science discussed in the stimulus. If they were ardent supporters of NASA to begin with, we could not expect much favorable change in attitude as a result of the stimulus message. And if the students came to the study strongly opposed to NASA and related science, we would be overzealous to expect a complete shift in attitudes with such a brief message.

Self-report data also indicate that these participants were being presented with information they had not yet mastered, leaving them plenty of room to learn. Therefore, this group of students was an appropriate group with whom to test the pacing-comprehension-persuasion model.

Implications

Pilot versus Main Study

As the literature review asserted, motivation and opportunity matter. Differences in comprehension scores between the pilot study and the main experiment, and between the conditions within the main experiment, are undoubtedly a function of motivation and opportunity. In the language of the ELM, central processing of the message was more likely to occur in the conditions where motivation and opportunity were greater.

It is difficult to gauge the extent to which participants in the main study were more motivated by their own backgrounds, the opportunity to work individually or simply the experimental instructions compared to the participants in the pilot study. But clearly the students in the main study took the task more seriously. While 10 of 15 participants

(66.7%) in the pilot Web condition reported skipping or skimming sections of the message, only 2 of 24 participants (8.3%) reported such behavior in the combined Web and print conditions in the main study. Likewise, only 2 of 15 (13.3%) reported any re-reading in the pilot, while 21 of 24 (87.5%) reported re-reading parts or all of the material in the main study. It is therefore not surprising that the average comprehension score across all conditions in the main study was higher than the average score in the pilot.

In addition to the self-report data, time measurements suggest that students in the print and Web conditions in the main study took advantage of their control of pacing. On average, students in the control-of-pacing conditions spent 4 minutes and 43 seconds with the material while exposure time to verbal content was fixed at 3 minutes and 31 seconds (video) or 3 minutes and 38 seconds (radio) in the no-control-of-pacing conditions. Exposure time correlated positively and reliably with comprehension scores ($r = .55$, $p < .01$).

Main Study Implications

In the main study, where motivation and opportunity to process information were boosted, students who could control the pacing of the message learned more than students who could not control pacing. This basic hypothesis of the study was supported, affirming that control of pacing can make a difference in comprehension as it did with this particular message from NASA.

Although the positive effect for the presence of images on learning predicted in the second hypothesis was not supported, the visual images that accompanied the verbal material did not appear to get in the way of learning. That is, the images did not contribute significantly to learning outcomes, but they also did not interfere with the learning experience. The greatest comprehension scores (M = 12.69) were in the Web condition while the lowest comprehension scores (M = 9.33) were in the radio condition, and the difference between these two groups was significant. Having control of pacing along with visual information provided an advantage in learning.

Based on the third and fourth hypothesis tests, control of pacing did not affect attitudes in the predicted direction. Neither did the presence of images. In fact, the effect for control of pacing in the 2X2 ANOVA was significant in the opposite direction of predictions. That is, students in the radio and video conditions ended up with more favorable attitudes toward the work scientists at NASA are doing. Why? Does this finding refute the ELM since greater elaboration and comprehension were predicted to result in greater persuasion based on this model?

At first glance, the response to the question of 'why' is that students who learned more as a result of their control of pacing processed the information via the central route and were affected negatively–the more they learned, the less they supported the science they were reading about–possibly as a result of counterarguing. But a closer look at the data makes this explanation unacceptable. A closer look at the data also shows how slippery the ELM can be in terms of falsifiability.

If the effect observed here represented a negative relationship between understanding and attitudes, and if what students were learning made them less favorable toward NASA's science, then we would expect a negative correlation between comprehension scores and the index of attitudes toward NASA/Marshall's science. But this correlation (the opposite of which was predicted in H_5) was insignificant. The correlation between comprehension and attitudes toward science and technology in general was also insignificant.

Yet post hoc analyses showed that attitudes toward NASA/Marshall's science in the video condition (M = 3.67) were significantly more favorable than print (M = 3.29) and Web (M = 3.21) conditions. It should be noted again here that these were not drastic changes in attitudes, but they are reliable and must be discussed. Also, post hoc analyses of the question, "is the government spending too little, about the right amount or too much money on exploring space?" showed that students in the video and radio conditions were significantly more generous in their responses than those in the print condition.

The ELM offers a second explanation for these results. According to the model, if comprehension and central processing of the stimulus material did not affect attitudes, then attitudes may have changed via the peripheral route. Facial expressions and vocal inflections that were available as peripheral cues in the no-control-of-pacing conditions, especially the video condition, may have caused attitude change.

If this was the case, gains in understanding were less an influence on attitudes than peripheral cues, and attitudes were changed via the peripheral route. The limited information presented in the short stimuli simply may not have been enough to influence attitudes via the central route. This explanation is consistent with the chi-square tests of individual items where whether or not students voiced an opinion or answered "don't know" was not dependent on control of pacing. That is, we would expect fewer students to answer "don't know" in the control-of-pacing conditions if they were basing their opinions on knowledge gained from the stimulus–if their attitudes were formed via the central route. Likewise, students did not report being any more informed on the issues discussed in the stimulus in the control-of-pacing conditions. Furthermore, the correlation between comprehension scores and the informed index was near zero (r = .02) and not significant. These analyses all suggest that the verbal material merely showcased the science being conducted at Marshall's space sciences laboratory and did not provide a detailed and compelling enough argument to persuade students via the central route. Such a compelling, persuasive appeal would take more resources on the parts of both the communicator and the receivers of information to be effective.

From the data collected in this study, then, we can only conclude with certainty that the comprehension-persuasion link does not hold up for this particular message with this particular group of people. That is, gaining a basic understanding of the material showcased in the stimuli was not enough to affect attitudes via the central route. And we cannot complete the *general* statement, "if people only understood . . ." with any confidence.

At the same time, we cannot reject the ELM. Herein lies the epistemological problem. The ELM accounts for the results of this study no matter what direction they take. The data here show an increase in comprehension created by offering students control of pacing, but this increase in comprehension is not accompanied by greater persuasion. Instead it comes with less favorable attitudes. But even when the study results in effects opposite of the hypotheses, the ELM has an answer: if attitudes were not changed via the central route, then they must have changed via the peripheral route. No matter how the results of this study turned out, the ELM supplies a possible explanation.

The ELM provides a post hoc *description* of the persuasive processes at work in this study, but it did not help *predict* the results. Therefore, we must ask whether failure to predict results in this study resulted from a slippery theory or faulty experimental design, or both. What could have been done to make the ELM's predictions work?

Three factors may have been at work that may account for the wrong predictions. First, participants may not have been motivated and/or had the opportunity to process the information via the central route. Second, they may have been motivated and had the opportunity, but the message was not cogent enough. Third, one of the first two factors was compounded by peripheral cues that persuaded participants in the opposite direction as predicted.

To assure that participants are motivated and able to process the message, we need to know who these people are and what interests they may have vested in the material they are exposed to. We also need to know about the environment in which they receive the message to be sure that they are not externally constrained in their attempts to understand the material.

This experimental design (including the pilot study) provided controls on both motivation and opportunity in ways that already sacrifice the generalizability of the results to other circumstances. As discussed above, the recruitment of participants, the experimental instructions and the experimental procedure were all designed to boost motivation to process. More drastic measures could be taken (e.g., making course credit contingent on comprehension test performance), but doing so would further weaken the external validity of the design to a point where it would be tricky to imagine the results being meaningful outside the lab. Opportunity to process was manipulated with control of pacing in the different media conditions. Opportunity was a factor, but it was associated with greater comprehension.

The second factor, message quality, is a much more likely candidate for a weakness in design that can be improved. But how can we determine the cogency of a message in advance of an experiment? Clearly, the message can be pretested (as earlier researchers in this body of literature have done) to determine whether it is of sufficient quality to persuade people. But, if we have to pretest the message to ensure that it is persuasive, then what does a theory on persuasion predict that we do not already know?

According to the ELM peripheral cues come into play when there is fallout with motivation and opportunity. Predicting when people will use the peripheral route instead of the central route has been a strength of the ELM in past research. But motivation and opportunity to process were present in this study, and the central route to persuasion was not successful. The main purpose of this experiment was to test hypotheses within the central route, where persuasion comes as a result of learning, where it matters most to the communication professionals discussed at the outset of this study, and where peripheral cues should not play a significant role according to the ELM.

Conclusions and Directions for Future Research

For Theorists

The ELM is helpful when we want to describe and predict differences among central and peripheral routes to persuasion. In past research, experimenters have made successful predictions about which route receivers will employ based on variables such as the personal relevance of the message to the receiver. But these predictions only work when the cogency of a message has been determined in advance.

Whereas the message in the present study was truthful and provided significant variation in comprehension between conditions, and the control-of-pacing manipulation demonstrated significant comprehension effects in the predicted direction, the message itself did not persuade receivers to support the science it discussed.

Both the ELM and the message used in this particular experiment, then, have limitations that introduce intriguing areas for future research.

The ELM can always offer a post hoc explanation of how attitudes changed, but without prior knowledge of whether a message is cogent or not, the ELM is no help in predicting persuasive outcomes. What happens *within* the central route? To get a better understanding of the central route, and to make predictions about the comprehension-persuasion relationship within the central route, we need to focus more on what makes a message work. Simply being truthful and accurate is not enough to be persuasive. Although the question of what makes a message persuasive is as old as the study of rhetoric, findings from this study suggest that characteristics of media such as control of pacing give some media an advantage in presenting information over others. How can these advantages be exploited, or how can disadvantages be compensated for, to make truthful messages more persuasive via the central route? Researchers working within the ELM framework have examined the effects of some rhetorical devices in activating central processing (e.g., surprising headlines and the use of summary questions) on persuasion. The efficacy of these devices should be explored further with different media, and other rhetorical devices should be examined to determine the constraints and advantages various media may have.

Above all, however, future theory building in the area of media differences should focus primarily on the content of the message being conveyed with the constraints and advantages of various media examined as they interact with the message they deliver.

For Professionals

This study demonstrates the advantage some media can have over others in terms of control of pacing. All media, old and new, can be classified by the amount of control of pacing they allow receivers. Media that allow receivers control of pacing allow receivers to process information at their self-chosen optimal pace. This experiment showed the advantages media such as print and the Web may have over media such as radio and television. But this does not mean that accurate and true messages presented in media that give people control of pacing necessarily will be more persuasive than similar messages in other media. This advantage is very much dependent on the validity of the content of the message being delivered.

Public relations practitioners and other communicators using mass media as vehicles for learning and persuasion must consider the message they want to send, the goals they have for that message and the advantages and limitations of their media options for delivering the message. The advantages and disadvantages of specific media depend on the people receiving the message, the message being sent, and the intentions of the communicator.

When the intentions of the communicator are in line with modern prescriptive models of public relations such as those forwarded by the Grunigs, the intended effects will include understanding and comprehension as a foundation for any persuasion. Communicators should exploit the advantages of media that allow receivers to choose their own optimal pace of processing. Preparing messages on complex or detailed subject matter for media such as the Web and print means that the intended outcomes of such writing are less likely to be lost due to lack of understanding. But the messages can fail quickly–in these media just as any other media–due to lack of interest and to countless other shortcomings in the way information is written and presented.

Techniques from the fields of rhetoric, literature and literary studies, film and instructional design are important sources for improving message quality that studies in mass communication and social psychology can supplement but not replace.

For Teachers

Teachers can use the implications as subject matter in teaching communication. Students of communication must learn to think of the receiver of their messages in order to write, produce or illustrate effectively. **This study highlights the importance of considering receivers' opportunity to process messages as a function of medium in achieving the intended effects of the message. But it also reminds us that media have no effects independent of content.**

In other words, if a message is not written well in the first place, no amount of media technology will make it effective. The message used in this study was successfully written to inform, but it did not persuade. The difference between these two effects, and why they do not always go hand in hand, is an intriguing topic to explore in the communications classroom.

Communication teachers and students must wrestle with the same issues as professional communicators–how to take advantage of some media's strength in allowing receivers control of pacing and how to compensate for the weaknesses of other media in the same area.

In the public relations classroom, comprehension must be discussed as a critical step in the process of persuasion if relationships between organizations and their publics are going to be based on mutual understanding.

General Conclusions

Again, this dissertation demonstrates how media differences–specifically receiver control of pacing–can help or hinder communication via mass media in terms of comprehension. This dissertation also highlights the difficulty of changing attitudes with a limited amount of information. A short video segment or one-page newsletter offering a brief overview of the complex goals of an organization was not sufficient to achieve a level of understanding in which attitude change occurred via the central route. Rather, such a message can only be seen as a small contribution to the two-way communication necessary for building a strong relationship between an organization and its publics. That is, this type of message combined with other communications in a two-way conversation, including longer, more thorough messages, can provide a productive contribution to the relationship-building process.

As a deeper mutual understanding is built, the likelihood of persuasion via the central route can be expected to increase. Future research should continue to address the quantity and quality of communication and understanding that is necessary for such persuasion to occur and how messages interact with media to affect comprehension and persuasion.

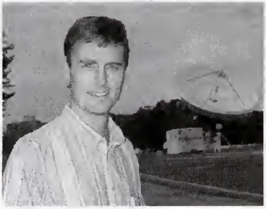
APPENDIX A
WEB PAGE STIMULUS (BLACK AND WHITE PRINTOUT)

Marshall Space Flight Center

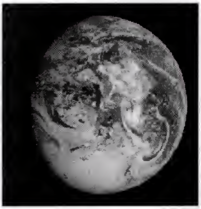
Science In the National Interest

Highlights From 1997

John Horack (at right) -- "1997 was a wonderful year for science at NASA's Marshall Space Flight Center as we conducted research from space, in space and about space in support of NASA's primary science enterprises: the human exploration and development of space, earth science and space sciences research."



Research From Space



Roy Spencer --"Monitoring the earth's temperature from space is definitely a challenging task, partly because the expected warming signal that we expect from global warming is so small compared to natural variability. For instance, the surface temperature measurements from thermometers suggest that the earth is warming slightly. However, higher up in the atmosphere where we measure with satellites, we find that the air is actually cooling slightly, and still higher in the stratosphere, we find a very strong cooling signal."

Dale Quattrochi -- "The urban heat island experiment helped us better understand the role that trees can play in keeping cities livable. Trees absorb sunlight and provide shade, and by comparing temperature measurements on the ground with those obtained from aircraft and from satellites in space, it provides the information that is needed to map hot spots and cool areas within cities."

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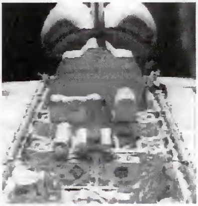
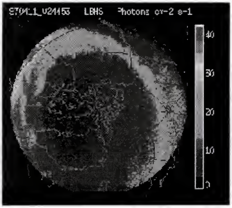
Peter Curreri-- "The fourth United States Microgravity Payload was an outstanding combination of crew operations and remote controlled science. Together they delivered world-class science that will affect the design of jet engines and 21st Century electronics."



Research About Space



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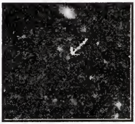
Jerry Fishman-- "Gamma ray bursts are one of the biggest mysteries in modern astrophysics. The BATSE experiment on the Compton Gamma Ray Observatory has now observed more than 2000 gamma ray bursts and shown that bursts are near the edge of the observable universe. But the fun's not over. A few visible counterparts to bursts have been seen and we still have to figure out just what causes bursts and what it means for our own galaxy."



Click above to see a larger image file.

Click above to see animated image.

John Horack --"1998 promises to be just as exciting as 1997. A new lightning imaging sensor is on orbit and mapping thunderstorms. We're preparing a new X-ray astronomy telescope for launch, and we're taking lessons learned from Spacelab missions and getting ready to do science aboard the International Space Station. The results from our research today are a gift to our children tomorrow."

SPACE SCIENCE NEWS

science.nasa.gov

Marshall Space Flight Center

APPENDIX B
PILOT QUESTIONNAIRE

Please circle the best answer for the following questions and fill in the blanks where necessary.

Which of the following best describes your reading of the material?

1. I didn't really read it.
2. I skimmed through parts of it and skipped other parts.
3. I read through some of it thoroughly one time, but skipped other parts altogether.
4. I read through some of it thoroughly one time, and I skimmed the rest.
5. I read through some of it multiple times and skipped or skimmed other parts.
6. I read through all of it one time.
7. I read through some of it once and I read the rest more than once.
8. I read through all of it more than once.

9. Other: ____

There are a lot of issues in the news, and it is hard to keep up with every area. For each of the following issues, please indicate **your level of interest** by circling a number.

ISSUES ABOUT...	*NOT AT ALL INTERESTED*	*MILDLY INTERESTED*	*MODERATELY INTERESTED*	*QUITE INTERESTED*	*VERY INTERESTED*
international and foreign policy	1	2	3	4	5
agriculture and farming	1	2	3	4	5
local schools	1	2	3	4	5
new scientific discoveries	1	2	3	4	5
economic and business conditions	1	2	3	4	5
the use of new inventions and technologies	1	2	3	4	5
the use of nuclear energy to generate electricity	1	2	3	4	5
new medical discoveries	1	2	3	4	5
space exploration	1	2	3	4	5
environmental pollution	1	2	3	4	5
military and defense policy	1	2	3	4	5
global temperature trends	1	2	3	4	5
urban heat islands	1	2	3	4	5
microgravity science	1	2	3	4	5
how solar events affect earth	1	2	3	4	5
gamma ray bursts	1	2	3	4	5

Please go through the list again and indicate **how informed you are on each issue** by circling a number.

ISSUES ABOUT…	*NOT AT ALL INFORMED*	*MILDLY INFORMED*	*MODERATELY INFORMED*	*QUITE INFORMED*	*VERY INFORMED*
international and foreign policy	**1**	**2**	**3**	**4**	**5**
agriculture and farming	**1**	**2**	**3**	**4**	**5**
local schools	**1**	**2**	**3**	**4**	**5**
new scientific discoveries	**1**	**2**	**3**	**4**	**5**
economic and business conditions	**1**	**2**	**3**	**4**	**5**
the use of new inventions and technologies	**1**	**2**	**3**	**4**	**5**
the use of nuclear energy to generate electricity	**1**	**2**	**3**	**4**	**5**
new medical discoveries	**1**	**2**	**3**	**4**	**5**
space exploration	**1**	**2**	**3**	**4**	**5**
environmental pollution	**1**	**2**	**3**	**4**	**5**
military and defense policy	**1**	**2**	**3**	**4**	**5**
global temperature trends	**1**	**2**	**3**	**4**	**5**
urban heat islands	**1**	**2**	**3**	**4**	**5**
microgravity science	**1**	**2**	**3**	**4**	**5**
how solar events affect earth	**1**	**2**	**3**	**4**	**5**
gamma ray bursts	**1**	**2**	**3**	**4**	**5**

All things considered, would you say that the world is better off or worse off because of science?

____

Please indicate your **level of agreement** with the following statements by circling a number.

	Strongly Disagree	*Disagree*	*Don't Know*	*Agree*	*Strongly agree*
Science and technology are making our lives healthier, easier and more comfortable.	**1**	**2**	**3**	**4**	**5**
The quality of science and mathematics education in American schools is inadequate.	**1**	**2**	**3**	**4**	**5**
In general, computers will create more jobs than they will eliminate.	**1**	**2**	**3**	**4**	**5**
In general, factory automation will create more jobs than it will eliminate.	**1**	**2**	**3**	**4**	**5**
We depend too much on science and not enough on faith.	**1**	**2**	**3**	**4**	**5**
Even if it brings no immediate benefits, scientific research which advances the frontiers of knowledge is necessary.	**1**	**2**	**3**	**4**	**5**
Even if it brings no immediate benefits, scientific research which advances the frontiers of knowledge should be supported by the federal government.	**1**	**2**	**3**	**4**	**5**
Scientists should be able to do research that causes pain and injury to animals like dogs and chimpanzees if it produces new information about human health problems.	**1**	**2**	**3**	**4**	**5**
It is not important for me to know about science in my daily life.	**1**	**2**	**3**	**4**	**5**
The American space program should build a space station large enough to house scientific and manufacturing experiments.	**1**	**2**	**3**	**4**	**5**
Some numbers are especially lucky for some people.	**1**	**2**	**3**	**4**	**5**
Science makes our way of life change too fast.	**1**	**2**	**3**	**4**	**5**
Most scientists want to work on things that will make life better for the average person.	**1**	**2**	**3**	**4**	**5**
Technological discoveries will eventually destroy the earth.	**1**	**2**	**3**	**4**	**5**
With the application of science and new technology, work will become more interesting.	**1**	**2**	**3**	**4**	**5**
Because of science and technology, there will be more opportunities for the next generation.	**1**	**2**	**3**	**4**	**5**
Technological development creates an artificial and inhuman way of living.	**1**	**2**	**3**	**4**	**5**
Scientists should be allowed to do research that causes pain and injury to animals like mice if it produces new information about human health problems.	**1**	**2**	**3**	**4**	**5**
New inventions will always be found to counteract any harmful consequences of technological development.	**1**	**2**	**3**	**4**	**5**
People would do better by living a simpler life without so much technology.	**1**	**2**	**3**	**4**	**5**

Please indicate **your level of agreement** with the following statements by circling a number.

	Strongly Disagree	*Disagree*	*Don't Know*	*Agree*	*Strongly Agree*
Scientific research on global temperature trends is necessary.	1	2	3	4	5
Scientific research on global temperature trends should be supported by the federal government.	1	2	3	4	5
Scientific research on urban heat islands is necessary.	1	2	3	4	5
Scientific research on urban heat islands should be supported by the federal government.	1	2	3	4	5
Microgravity science is necessary.	1	2	3	4	5
Microgravity science should be supported by the federal government.	1	2	3	4	5
Scientific research on how solar events affect earth is necessary.	1	2	3	4	5
Scientific research on how solar events affect earth should be supported by the federal government.	1	2	3	4	5
Scientific research on gamma ray bursts is necessary.	1	2	3	4	5
Scientific research on gamma ray bursts should be supported by the federal government.	1	2	3	4	5
It is important for me to know about science in my daily life.	1	2	3	4	5

Which area of science would you like to learn more about?

1. global temperature trends
2. urban heat islands
3. microgravity science
4. solar events
5. gamma ray bursts

People have frequently noted that scientific research has produced both beneficial and harmful consequences. Would you say that, on balance, the benefits of scientific research have outweighed the harmful results, or have the harmful results of scientific research been greater than its benefits? Please select one answer.

1. Beneficial results much greater
2. Beneficial results slightly greater
3. Results about equal
4. Harmful results slightly greater
5. Harmful results much greater
6. Don't know

Many current issues in science and technology may be viewed as a judgment of relative costs and benefits. Thinking about the space program, some persons have argued that the cost of the space program may have exceeded its benefits, while other people have argued that the benefits of space exploration have exceeded its costs. In your opinion, have the costs of space exploration exceeded its benefits, or have the benefits of space exploration exceeded its costs?

1. Benefits substantially greater
2. Benefits slightly greater
3. Benefits about equal to costs
4. Costs slightly greater
5. Costs substantially greater
6. Don't know

Is the government spending too little money, about the right amount, or too much on exploring space?

1. Too little
2. About the right amount
3. Too much
4. Don't know

Is the government spending too little money, about the right amount, or too much on supporting scientific research?

1. Too little
2. About the right amount
3. Too much
4. Don't know

Please answer the following questions carefully based on the material from NASA presented to you at the start of this study.

How was the science conducted at Marshall Space Flight Center categorized?

1. earth science, water science and space science
2. geology, hydrology and astrology
3. geology, hydrology and astronomy
4. in space, from space and about space

Why is monitoring the earth's temperature from space a challenging task?

1. the lack of oxygen and other key gases in space
2. the lack of mercury and other heavy metals in space
3. the temperature trends that scientists are looking for are small compared to the earth's natural variability in temperatures
4. the light reflected back to space by clouds and large bodies of water temporarily "blinds" space instruments

Why are scientists concerned about the difference in findings between instruments that measure the earth's temperature from space and instruments that measure the earth's temperature from its surface?

1. the findings suggest different trends in global temperature change
2. the findings suggest calibration problems with the surface instruments
3. the findings suggest calibration problems with the space instruments
4. the surface instruments do not account for gamma rays

What do surface temperatures from thermometers on earth suggest about long-term temperature trends?

1. slight global warming
2. slight global cooling
3. neutral variability
4. surface thermometers do not provide reliable measurements

What do atmospheric temperatures taken from satellites in space suggest about long-term temperature trends?

1. slight global warming
2. slight global cooling
3. neutral variability
4. space thermometers still need to be developed more before they will offer reliable measurements

How would you explain the relationship between the altitude of temperature measuring devices and the long-term temperature trends that these measurement devices suggest?

1. higher instruments suggest more of a cooling trend
2. higher instruments suggest more of a warming trend
3. higher instruments are less reliable
4. higher instruments are more reliable

How was the “urban heat island” experiment conducted?

1. by comparing temperatures of island cities with temperatures of landlocked cities
2. by analyzing temperature measurements on the ground along with measurements taken from planes and spacecraft
3. by analyzing smog (ozone) counts and emissions standards in urban areas
4. by making longitudinal observations of a single city's temperature changes over the course of 12 months and comparing those observations to usage of electricity in that area

What did the urban heat island experiment help scientists understand?

1. how trees help keep cities livable
2. how electric bills vary as a function of outside temperatures
3. how cloud particles interact with smog (ozone) to insulate heat
4. how to map lightning storms in urban areas

How do trees affect urban heat islands?

1. they act as filters for harmful airborne chemicals
2. they reflect sunlight and they reflect radiation such as gamma rays
3. they reflect sunlight and absorb water vapor
4. they provide shade and absorb sunlight

What kind of work did the scientists do aboard the microgravity science laboratory mission?

1. gamma ray astronomy
2. lightning research
3. combustion and materials science experiments
4. horticultural and biological science experiments

What did these microgravity experiments prepare scientists for in the future?

1. work on the International Space Station
2. gamma ray storms
3. anomalies
4. astrophysics projects

What areas of future technology will be affected most by the microgravity research conducted in 1997?

1. telescopes and radiometers
2. alternative fuel systems for ground transportation
3. corrective propulsion systems for satellites
4. jet engines and electronics

According to one scientist, the fourth United States Microgravity Payload combined…

1. crew operations and remote controlled science
2. oil-based liquids with water-based liquids
3. the sun's direct radiation with the earth's reflective radiation
4. astronaut optimism and scientific integrity

What did scientists observe affecting the earth's aurora?

1. the moon
2. the sun
3. pollution
4. surface temperature changes

How did scientists observe this effect on the earth's aurora?

1. in degrees Fahrenheit
2. in gamma rays
3. in degrees Celsius
4. in ultraviolet

Where do scientists believe gamma ray bursts come from?

1. "man-made nuclear devices"
2. "somewhere within our galaxy"
3. "the sun's inner core"
4. "the edge of the observable universe"

What evidence have scientists observed to learn about gamma ray bursts?

1. atmospheric temperature changes
2. visible counterparts to gamma ray bursts
3. the sun's coronal mass ejections
4. predictable changes in the apparent position of stars within our galaxy

Thank you again for participating!

APPENDIX C
NEWSLETTER STIMULUS (BLACK AND WHITE PRINTOUT)

Marshall Space Flight Center

Science in the National Interest

Highlights From 1997

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Research From Space

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APPENDIX D
MAIN STUDY QUESTIONNAIRE

Please circle the best answer for the following questions and fill in the blanks where necessary.

Which of the following best describes your reading of the material?

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2. I skimmed through parts of it and skipped other parts.
3. I read through some of it thoroughly one time, but skipped other parts altogether.
4. I read through some of it thoroughly one time, and I skimmed the rest.
5. I read through some of it multiple times and skipped or skimmed other parts.
6. I read through all of it one time.
7. I read through some of it once and I read the rest more than once.
8. I read through all of it more than once.
9. Other: ______________________________

There are a lot of issues in the news, and it is hard to keep up with every area. For each of the following issues, please indicate **your level of interest** by circling a number.

ISSUES ABOUT...	*NOT AT ALL INTERESTED*	*MILDLY INTERESTED*	*MODERATELY INTERESTED*	*QUITE INTERESTED*	*VERY INTERESTED*
new scientific discoveries	1	2	3	4	5
the use of new inventions and technologies	1	2	3	4	5
space exploration	1	2	3	4	5
environmental pollution	1	2	3	4	5
military and defense policy	1	2	3	4	5
global temperature trends	1	2	3	4	5
urban heat islands	1	2	3	4	5
microgravity science	1	2	3	4	5
how solar events affect earth	1	2	3	4	5
gamma ray bursts	1	2	3	4	5

Please go through the list again and indicate **how informed you are on each issue** by circling a number.

ISSUES ABOUT...	*NOT AT ALL INFORMED*	*MILDLY INFORMED*	*MODERATELY INFORMED*	*QUITE INFORMED*	*VERY INFORMED*
new scientific discoveries	**1**	**2**	**3**	**4**	**5**
the use of new inventions and technologies	**1**	**2**	**3**	**4**	**5**
space exploration	**1**	**2**	**3**	**4**	**5**
environmental pollution	**1**	**2**	**3**	**4**	**5**
military and defense policy	**1**	**2**	**3**	**4**	**5**
global temperature trends	**1**	**2**	**3**	**4**	**5**
urban heat islands	**1**	**2**	**3**	**4**	**5**
microgravity science	**1**	**2**	**3**	**4**	**5**
how solar events affect earth	**1**	**2**	**3**	**4**	**5**
gamma ray bursts	**1**	**2**	**3**	**4**	**5**

All things considered, would you say that the world is better off or worse off because of science?

____

Please indicate your **level of agreement** with the following statements by circling a number.

	Strongly Disagree	*Disagree*	*Neutral*	*Agree*	*Strongly agree*
Science and technology are making our lives healthier, easier and more comfortable.	1	2	3	4	5
We depend too much on science and not enough on faith.	1	2	3	4	5
Even if it brings no immediate benefits, scientific research which advances the frontiers of knowledge is necessary.	1	2	3	4	5
Even if it brings no immediate benefits, scientific research which advances the frontiers of knowledge should be supported by the federal government.	1	2	3	4	5
It is not important for me to know about science in my daily life.	1	2	3	4	5
The American space program should build a space station large enough to house scientific and manufacturing experiments.	1	2	3	4	5
Science makes our way of life change too fast.	1	2	3	4	5
Most scientists want to work on things that will make life better for the average person.	1	2	3	4	5
With the application of science and new technology, work will become more interesting.	1	2	3	4	5
Because of science and technology, there will be more opportunities for the next generation.	1	2	3	4	5
Scientific research on global temperature trends is necessary.	1	2	3	4	5
Scientific research on global temperature trends should be supported by the federal government.	1	2	3	4	5
Scientific research on urban heat islands is necessary.	1	2	3	4	5
Scientific research on urban heat islands should be supported by the federal government.	1	2	3	4	5
Microgravity science is necessary.	1	2	3	4	5
Microgravity science should be supported by the federal government.	1	2	3	4	5
Scientific research on how solar events affect earth is necessary.	1	2	3	4	5
Scientific research on how solar events affect earth should be supported by the federal government.	1	2	3	4	5
Scientific research on gamma ray bursts is necessary.	1	2	3	4	5
Scientific research on gamma ray bursts should be supported by the federal government.	1	2	3	4	5
It is important for me to know about science in my daily life.	1	2	3	4	5

Which area of science would you like to learn more about?

1. global temperature trends
2. urban heat islands
3. microgravity science
4. solar events
5. gamma ray bursts

People have frequently noted that scientific research has produced both beneficial and harmful consequences. Would you say that, on balance, the benefits of scientific research have outweighed the harmful results, or have the harmful results of scientific research been greater than its benefits? Please select one answer.

1. Beneficial results much greater
2. Beneficial results slightly greater
3. Results about equal
4. Harmful results slightly greater
5. Harmful results much greater
6. Don't know

Many current issues in science and technology may be viewed as a judgment of relative costs and benefits. Thinking about the space program, some persons have argued that the cost of the space program may have exceeded its benefits, while other people have argued that the benefits of space exploration have exceeded its costs. In your opinion, have the costs of space exploration exceeded its benefits, or have the benefits of space exploration exceeded its costs?

1. Benefits substantially greater
2. Benefits slightly greater
3. Benefits about equal to costs
4. Costs slightly greater
5. Costs substantially greater
6. Don't know

Is the government spending too little money, about the right amount, or too much on exploring space?

1. Too little
2. About the right amount
3. Too much
4. Don't know

Is the government spending too little money, about the right amount, or too much on supporting scientific research?

1. Too little
2. About the right amount
3. Too much
4. Don't know

Please answer the following questions carefully based on the material from NASA presented to you at the start of this study.

How was the science conducted at Marshall Space Flight Center categorized?

1. earth science, water science and space science
2. geology, hydrology and astrology
3. geology, hydrology and astronomy
4. in space, from space and about space

Why is monitoring the earth's temperature from space a challenging task?

1. the lack of oxygen and other key gases in space
2. the lack of mercury and other heavy metals in space
3. the temperature trends that scientists are looking for are small compared to the earth's natural variability in temperatures
4. the light reflected back to space by clouds and large bodies of water temporarily "blinds" space instruments

Why are scientists concerned about the difference in findings between instruments that measure the earth's temperature from space and instruments that measure the earth's temperature from its surface?

1. the findings suggest different trends in global temperature change
2. the findings suggest calibration problems with the surface instruments
3. the findings suggest calibration problems with the space instruments
4. the surface instruments do not account for gamma rays

What do surface temperatures from thermometers on earth suggest about long-term temperature trends?

1. slight global warming
2. slight global cooling
3. neutral variability
4. surface thermometers do not provide reliable measurements

What do atmospheric temperatures taken from satellites in space suggest about long-term temperature trends?

1. slight global warming
2. slight global cooling
3. neutral variability
4. space thermometers still need to be developed more before they will offer reliable measurements

How would you explain the relationship between the altitude of temperature measuring devices and the long-term temperature trends that these measurement devices suggest?

1. higher instruments suggest more of a cooling trend
2. higher instruments suggest more of a warming trend
3. higher instruments are less reliable
4. higher instruments are more reliable

How was the “urban heat island” experiment conducted?

1. by comparing temperatures of island cities with temperatures of landlocked cities
2. by analyzing temperature measurements on the ground along with measurements taken from planes and spacecraft
3. by analyzing smog (ozone) counts and emissions standards in urban areas
4. by making longitudinal observations of a single city's temperature changes over the course of 12 months and comparing those observations to usage of electricity in that area

What did the urban heat island experiment help scientists understand?

1. how trees help keep cities livable
2. how electric bills vary as a function of outside temperatures
3. how cloud particles interact with smog (ozone) to insulate heat
4. how to map lightning storms in urban areas

How do trees affect urban heat islands?

1. they act as filters for harmful airborne chemicals
2. they reflect sunlight and they reflect radiation such as gamma rays
3. they reflect sunlight and absorb water vapor
4. they provide shade and absorb sunlight

What kind of work did the scientists do aboard the microgravity science laboratory mission?

1. gamma ray astronomy
2. lightning research
3. combustion and materials science experiments
4. horticultural and biological science experiments

What did these microgravity experiments prepare scientists for in the future?

1. work on the International Space Station
2. gamma ray storms
3. anomalies
4. astrophysics projects

What areas of future technology will be affected most by the microgravity research conducted in 1997?

1. telescopes and radiometers
2. alternative fuel systems for ground transportation
3. corrective propulsion systems for satellites
4. jet engines and electronics

According to one scientist, the fourth United States Microgravity Payload combined…

1. crew operations and remote controlled science
2. oil-based liquids with water-based liquids
3. the sun's direct radiation with the earth's reflective radiation
4. astronaut optimism and scientific integrity

What did scientists observe affecting the earth's aurora?

1. the moon
2. the sun
3. pollution
4. surface temperature changes

How did scientists observe this effect on the earth's aurora?

1. in degrees Fahrenheit
2. in gamma rays
3. in degrees Celsius
4. in ultraviolet

Where do scientists believe gamma ray bursts come from?

1. "man-made nuclear devices"
2. "somewhere within our galaxy"
3. "the sun's inner core"
4. "the edge of the observable universe"

What evidence have scientists observed to learn about gamma ray bursts?

1. atmospheric temperature changes
2. visible counterparts to gamma ray bursts
3. the sun's coronal mass ejections
4. predictable changes in the apparent position of stars within our galaxy

Thank you again for participating!

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BIOGRAPHICAL SKETCH

A native Floridian, Tom Kelleher was born and raised in North Palm Beach. He graduated *magna cum laude* from Flagler College in St. Augustine in December 1993 with a B.A. degree in communication. He began graduate school at the University of Florida in 1994 and earned a M.A. degree in mass communication in December 1996 and a Ph.D. degree in mass communication in May 1999.

As a doctoral student and doctoral candidate, Tom taught Principles of Public Relations for three semesters and Public Relations Writing for two semesters.

Tom balanced his early academic career with professional experience, including work in the Office of University Relations and the Office of the President at the University of Florida from January 1996 to May 1999. He also held communication positions at NASA's Marshall Space Flight Center Space Sciences Laboratory in Huntsville, Alabama, Ketchum Public Relations in Atlanta, Golden Bear International in North Palm Beach and the Historic St. Augustine Preservation Board in St. Augustine.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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